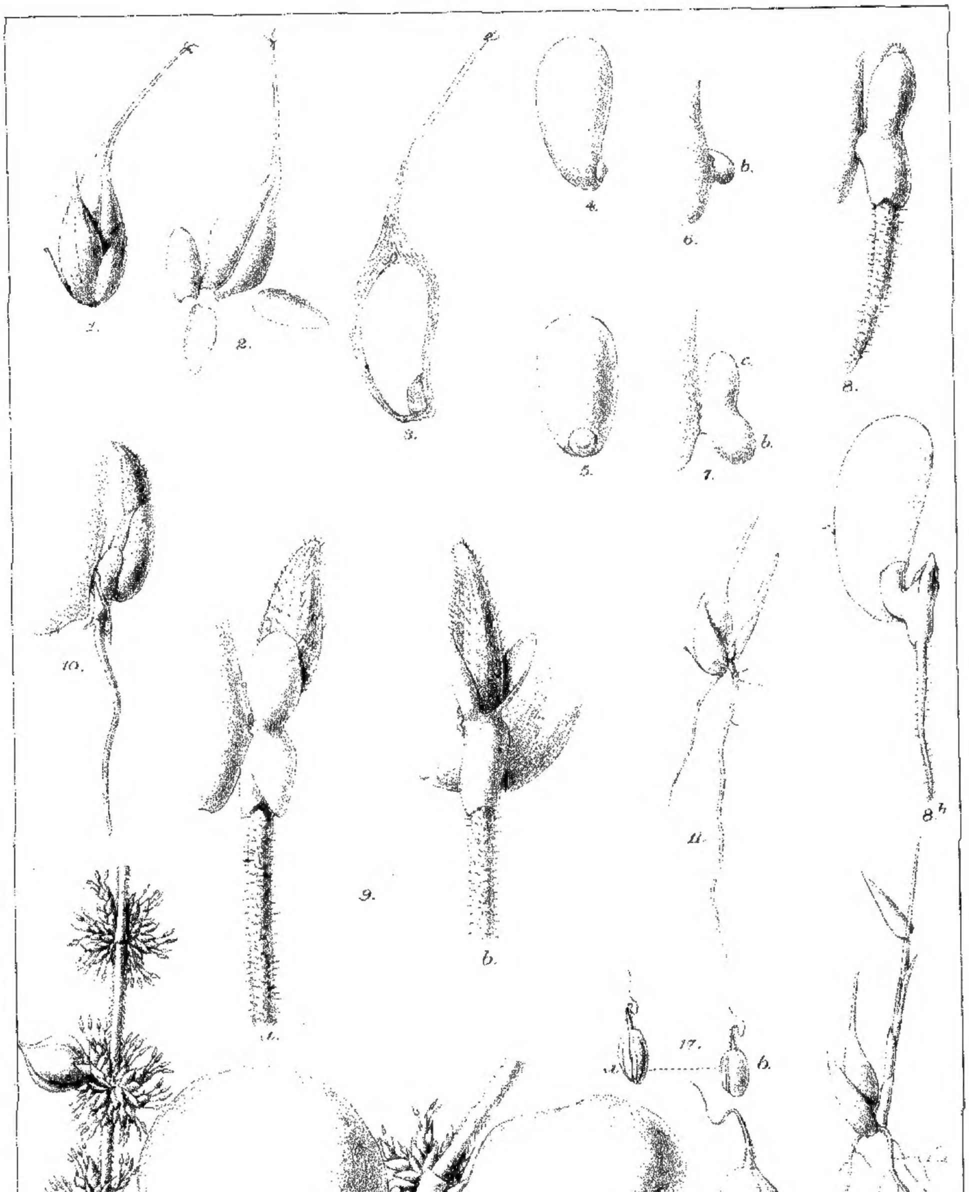
Plate.I.

S. Kurz. Del.

S. Sedgfield. Lith.

Plate II.



S. Kurz, Del. S. Sedgfield, Lith.

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Bamboo* and its use.

BY S. KURZ.

No plant is known in the tropical zone which could supply to man so many technical advantages as the bamboo. The strength of the halms, their straightness, smoothness, lightness combined with hardness and greater or less hollowness; the facility and regularity with which they can be split; the different sizes, various length and thickness of their joints makes them suitable for numerous purposes to serve which other materials would require much labour and preparation. To this must be added their abundance and the ease with which they are propagated. They are, as Mr. Alf. Wallace writes, at once the most wonderful and the most beautiful production of the tropics, and the best gift of nature to uncivilized man. Who never has travelled within the warm zone of our globe, can form only a very superficial idea of the real importance of bamboo. Wherever we cast here our eyes, these gigantic grasses meet us either in their natural state or by the industry of man transformed into the most varied objects. Without bamboo *the Indian would be poor, very poor indeed!*

The present demand for bamboo in forestry and manufacture, and more especially the recent agitation to use bamboo in the fabrication of paper, etc., may well excuse me if I have taken upon me the task of treating, however incompletely, not only the uses of these arboreous grasses, but also of offering some remarks on their general growth and habits, as well as on their specific differences. As however my researches of the British Indian and Eastern Asiatic species are not yet closed, I shall

* The vernacular names for bamboo generally are bans, *Bengali;* bamboo, *Malay;* awie, *Sundanese;* tring, *Javanese;* utte, in the Moluccas; Kây, *Siamese;* Wa, *Burmese;* chack or chouw, *Chinese.*

for the present treat those of the Indian Archipelago and of the Malayan countries. In doing so I include now already such general remarks on the continental species, as may not interfere with the special object under view.

The heads under which I arrange the matters connected with the practical treatment of bamboo, are the following :

1. Use of bamboo generally.
2. Habit and growth of bamboo.
3. Species of bamboo.
   a. Those of the Indian Archipelago and Malaya.
   b. Those of China and Japan.
   c. Those of the Indian Continent and adjacent islands.

I.—Use of Bamboo generally.*

One of the most important and prevalent applications of bamboo takes place in house building. Indeed, Indians might be classed into those that use bamboo in the construction of their dwellings, and those that use brick, mud or wood. The dreary aspect and poor condition of the people in mud-houses must gravely press upon the mind of those that have had opportunity to study the habits and healthy condition of the people that live in neat bamboo-houses.

It is of the greatest importance in applying bamboo for any building purpose, to see that the halms are cut in the proper season of the year. If cut just before the rains, they will be nearly eaten up by weevils ere the rains close ; but if felled at the close of the rains, they will often remain strong, and proof against the attacks of xylophagous insects, for 6 or 7 years. Immersion in water for a few weeks before use is generally adopted by the natives and renders them more

* Besides my own observations and those of friends, numerous books were consulted in the compilation of the uses, but chiefly the following treatises :

A. Wallace, on the bamboo and durian of Borneo (in Hooker's Journ. of Botany, VIII, 225 sqq.)

M. C. D. Edouard Mène Utilisation des bambou en China, (Journ. of Acclimat. Soc. of Paris).

Junghuhn's Java, F. Jagor Reiseskizzen Singapore, Malacca, and Java, and various articles contained in the volumes of the Transactions, Journals and Proceedings of the Agri-Horticultural Society of India.

Scientific names to the vernacular ones are only given once, but a list of the vernaculars and their botanical equivalents is appended to the end of this paper.

The general working in bamboo may be learnt from Jagor's Reisen in den Phillippinen, p. 36, with figures.

durable. However much depends upon the amount of silica, and those poorest in it are also the more perishable ones. In the Indian Archipelago the following kinds appeared to me to yield the more durable halms: bamboo bitoong (*Gigantochloa aspera*); b. andong bezar (*G. maxima*); b. atter (*G. atter*); b. hower (*Bambusa vulgaris*): while bamboo booloo (*Schizostachyum brachycladum*); b. awie? (*Sch. Blumei*); b. mayang (*Sch. longispiculatum*) and b. ietam (a variety of *G. atter*) are soon attacked by the boobook (*Bostrichus*). But Mr. Teysmann, whose long experience (over 35 years) in the Archipelago is a guarantee for the value of his observations, tells me that the following are quickly attacked by the boobook: bamboo atter, bitoong, wooloong (*Gig. robusta*); kriesik (*Schizo. Hasskarlianum*); lengka (*Giganto. nigrociliata*); booloo, andong kekeus (a variety of *Gig. maxima*); then follow bamboo ietam and b. dooree (*Bamb. Blumeana*). In return bamboo talie, b. andong bezar, b. hower and b. tootool (only a variety of hower) are those that last longest: although partly just the contrary of my own observations and those of Mr. Riggs of Jasinga (Buitenzorg, Java). On the Indian continent are chiefly used in house-building: behoor bans or Kya Katwa (*Bamb. arundinacea*); balkoobans (*Bamb. balcooa)*; pao (*Dendrocalamus Hamiltonii*); kyattounwa (*B. polymorpha*); and kyellowa or wabo (*B. Brandisii*).

In the construction of bamboo-houses the halms of different sorts of bamboo come in use according to their greater or lesser strength, etc. Thus, for example, the Javanese uses by preference the halms (*battang, mal.*) of b. bitoong and b. andong for the principal posts and scaffolding, on account of their strength and greater durability, while those of b. atter and b. apoos (*Schizo. Blumei*) serve more for the construction of walls, etc., because the halms of these two latter species are of less thickness of wood and have no prominent nodes. For this purpose the halms are split into four or five strips, which are flattened out and firmly tied down with rattan or bamboo strings to the rafters; but more usually these broad strips are either lengthwise crossed over the rafters or crosswise laid one upon another in such a way as to give the wall the appearance of a huge chest-board (the alternating strips being usually coloured black and white).

Similar but broader strips are used for flooring, and in this case the halms are split on one side only, flattened out so as to form beautiful slabs from 1 to 1½ feet broad, while the sharp prominences inside the nodes are carefully removed with the parang or dah (wood-cutting knives). Such floors are delightful to walk upon barefooted, and still more so to sleep upon with a mat over them on account of their elasticity and undulating nature. The houses are covered with various materials, especially atap (*Nipa fruticans*) leaves, but often enough also with bamboo tiles (sirab mal.) or bamboo halms cut into two (called talapap mal.) laid on in the same way as our wooden ones. Smaller pieces serve for window blinds. Thin split bamboo tied up with silk form roll curtains for verandas, which permit the air to pass, but also agreeably temper the glaring light, especially if, as is usually the case, they are dyed green. Houses build in the manner, as Malays and Burmans do, are not only good looking and comfortable, but also healthy, and this the more so as they are raised above the ground. They are usually build for a single family only, but the Dayaks of Borneo, like the Naga hill-people and other tribes of the Eastern frontier of Bengal, like the Karens of Burma, build large communal houses often 200 to 300 feet long by 50 to 100 feet broad. These are divided into as many compartments as there are families, which often number up to 100. I have seen tays (this is the name by which the communal Karen houses or rather villages are known), which were as much as 30 feet raised from the ground, and when the people therein rushed to one side, the whole structure would hang over. One cannot look then upon the tay without thinking it in imminent danger of tumbling down, but the elasticity and strength of the numerous supporting bamboo halms effectually prevents any such accidents. The space under these houses usually is used as sheds for cattle, pigs, fowls, etc. Fishermen often build their houses solely of bamboo on bamboo (or palm) poles far out into the tidal rivers and sheltered bays of the sea, so that they stand in the water up to near the floor with every recurring tide. These resemble remarkably the ancient *pile houses* of the Switzer lakes, and are similarly connected amongst another by galleries. The greater part of the inhabitants of Bang-

kok (Siam) live in bamboo-houses build upon bamboo-rafters and let themselves float with ebb or tide downwards or upwards the river as they choose. The theatres in China are all made of bamboo, and so are the Chinese theatres in the Malay countries. Even in European house building bamboo has become quite indispensable all over India, and bamboo-scaffoldings are in general use in building the largest palaces and houses in Calcutta, etc., etc.

If temporary shelter is required, either by the native or the traveller in the jungles, nothing is so convenient as the bamboo, and how quick do they finish such a temporary house! A few hours' patience and the traveller is comfortably housed for the night, having not only shelter above him, but also his table, chair and bali-bali (bedstead) all made of bamboo. The leaves of the wild plantain or other large scitamineae usually form in this case the roofing material.

The younger halms of bamb. talie (so is called the not full-grown bamb. apoos) are cut into longer or shorter thin strips (talie-string) and serve for cordage. These strings, while fresh, are as firm and strong as ordinary cordage and used for every purpose: the bamboo-slips of the house-walls not only, but also the atap (leaves of *nipa* and *sagguerus, etc.*) and the bamboo tiles that form the roof, are fastened by their aid; loads, heavy or light, or smaller articles bound up in leaves, etc., are fastened with this same material; indeed they are used generally for all purposes for which in a civilized country a rope-maker is required. The aborigines of the Nicobars use the very long cane like halms of *Cinochloa andamanica* (very nearly allied to the Tjangkorreh of Java) instead of ropes, with which they fasten the large masts (a superstitious usage) that are erected in the sea before every larger village somewhat in the way as the masts of a European ship.

Bamboo-bridges are in general use all over India and Eastern Asia, however more so in the Indian Archipelago. Bamboo is admirably adapted for this purpose, although the people rarely bestow much labour upon the keep of these bridges, and thus they are soon decaying or carried off by the flood-waters. But the material is so plentiful at hand, and it is so quickly re-

placed, that it is more economical to use bamboo instead of more durable timber. Even in the Himalayas, where cane bridges are preferred, bamboo usually forms in so far part of these as one or a few bamboo-halms are laid on lengthwise and form thus the foot-hold in the structure. In Borneo and elsewhere such bridges consist merely of bamboo halms, crossing each other at the road-way like the letter X, and rising, sometimes on one side, sometimes on both, 3 or 4 feet above it. At the crossing they are firmly bound together, and to a horizontal bamboo, which forms the only foot-path, with another higher up, serving as a hand-rail. In Java, etc., bridges are build of this material over rivers 60 to 80 feet broad, with railings, cross-supports, etc., somewhat after the fashion of suspension-bridges, which look ornamental and deserve all admiration. Over such bridges not only men with loads, but even ponies and light carts pass safely. But also true pontoon-bridges are constructed on the same island, where the pontoons are substituted by strong bamboo-rafts, which rise and fall with rise and fall of the river or of the tides.

Along precipitous declivities in the hills bamboo-bridges and railings are not rarely constructed on the same principle as our engineers in Europe do the wooden ones, but here trees and roots are made use of for suspension. These bridges are traversed daily by men and women, carrying heavy loads, so that any insecurity is soon discovered and immediately repaired. When the path goes over very steep and slippery ground, the bamboo is used to form steps. Pieces are cut, about a yard long, and opposite notches being made at each end, holes are formed, through which pegs (also made of bamboo) are driven, and a ladder or staircase is produced with the greatest celerity. But ladders or substitutes for them are constructed in the most simple way for climbing lofty trees, especially for the purpose of gathering fruit or of obtaining bees wax. This, as Wallace tells us, is done by means of bamboo-pegs driven into the smooth stems of the trees. These pegs are made of old thick bamboo, split to about two inches wide. Each is cut above a joint, which forms a solid head to bear the blows of the mallet, and the point is flat and broad, cut away carefully to the siliceous

outer-coating. To the head of each is strongly tied a strip of the rough rind of a water plant. The climber carries forty or fifty of these pegs in a basket by his side, and has a wooden mallet suspended round his neck; he has also prepared a number of strong, but slender bamboos, each from 20 to 30 feet long. One of these he sticks firmly in the ground at the foot of the tree, and close to it; he then drives a peg as high as he can reach, and ties it firmly by the head to the bamboo; climbing up upon this, he drives in and ties 2 other pegs, each about 3 feet from the one below it, passing his arms between the tree and the bamboo, to hold the peg while he is driving in. He soon reaches the top of his pole, when another one is handed up to him, and being bound to the one below, he ascends in the same way another 20 feet. When his pegs are exhausted, a boy brings a fresh basket full up to him, and a long cord enables him to pull up the bamboos as he requires them. This mode of ascent looks perilous, but is in reality perfectly secure. Each peg holds as tightly as a spike nail, besides which the weight is always distributed over a great number of them by means of the vertical bamboos. Exactly the same mode of climbing trees prevails amongst the Nagas of Eastern Bengal (see Peal, a visit to the Naga Hills; Journ. As. Soc., Beng., 1872, part 1, t. 5, left hand), and similarly amongst the Karens of Burma.

Bamboo-halms are also well adapted for aqueducts of a primary nature. The largest kinds of bamboo are taken for this purpose and split in half, supported on crossed poles of various height according to requirement. Also water-pipes are often made by simply perforating internally the solid nodes.

Although bamboo generally is not fit for the construction of boats or canoes, Chr. Costa tells us of a sort of bamboo in the Moluccos (most probably *Gig. maxima*), which produces such thick halms, that the single joints split in halves are used for little canoes, in which two men are said to find place! For masts and spars of small native vessels bamboo is in general use. The outriggers of canoes peculiar to the Phillipines and Ceylon are all of bamboo. The Nicobarese, who use similar outriggers, make them of light wood, because bamboo is, strangely to say, rare with them. The other parts of a boat, such as

cabins, etc., are usually constructed of bamboo on the same principle as houses. Bamboo is in use for rafts all over India and the Archipelago. These are simple or more usually doubled up, and in the latter case often furnished with ornamental railings. The construction of such a raft (including the cutting of the bamboo in the jungle) takes usually between 1 to 1½ hours time if done by men expert in such work. They may carry even a pony over deep waters. For floating of timber bamboo has become also highly important to the forester. For this purpose, of course, size and still more the hollowness of the halms are the principal requisites. Hence in the Archipelago bamb. apoos, b. andong, b. atter and others are useful, and in Burma chiefly waya (*Bambusa longispatha*); tin-wa (*Cephalostachyum pergracile*), wabo or kyellowa (*Bamb. Brandisii*). In Sikkim it is the pao (*Dendrocalamus Hamiltonii*) chiefly that is used for this purpose.

Several sorts of bamboo form good living hedges and are in this regard far superior to the artificial ones on account of their durability. The unarmed small species, especially the so-called China-bamboo (bamboo cheena, mal; Wa-pooloo-Pinang, Burm; *Bamb. nana*) is generally used in the Malay countries and southern parts of India. For hedges intended to prevent the entering of cattle or man, no other bamboo or material is more adapted for the purpose than behoor bans; or, as the Burmese call it, kyâkatwa, while in the Archipelago the very similar bamboo tyoo-tyook (*Bamb. Blumeana*) is still more effective, and forms much denser and impenetrable fences. How easily such hedges may be raised may readily be understood when I mention, that bamboo joints (with nodes on them), put in hedge-row take roots as readily as willows, and grow as rapidly if planted out just after the rains have set in or during the rainy season itself, but when done so in the dry season frequent watering is not always accompanied with success. By trimming, the bamboo hedges can be kept low.

But there is another application of bamboo which seems to be peculiar to the Malayan people, *viz.*, they use bamboo for the construction of triumphal arches and posts. No one who has not seen them can fairly appreciate the skill and taste display-

ed by the Javanese in this sort of work. Yesterday you saw nothing but a heap of fresh-cut bamboo-halms, and to-day these rude bamboo-poles gradually become converted into arches, gates, and structures of the most exquisite patterns. The principal arch with lateral ones, all formed of 4 to 6 cornered columns filled out with skillfully wreathed trellis-work, soon shew the style of workmanship, and, after the skeleton is thus formed, broad and thin-shaven strips of bamboo and the soft yellow sheaths of the plantain-leaves, taken from the interior layers of the trunk, are folded into artificial stars, flowers or mashes, and ornamentally arranged on the archings and columns. To these are also added guirlands (of bamboo material) intermingled with natural flowers which gracefully hang down according to tasteful designs. A few bouquets of natural and gorgeous flowers often are added as a finish.

The furniture of the Malays, Burmans and those people that live in tracts of India where bamboo abounds, is made chiefly of bamboo. Table, chair, waving-chairs, bench and other household articles down to the drinking cup are all made of bamboo. The greater portion of a bedstead is entirely of bamboo of different sizes, joined together by means of bamboo-pegs and bamboo-strings. Mattrasses, cushions and pillows are often stuffed with bamboo-shavings, although the cotton of *Bombax* and *Gossampinus* are more generally in use for this purpose. The bamboo-halms, says Rumphius, are in daily use for fetching water from the river. The longest joints of the greater sorts of bamboo [such as b. andong, b. atter, b. wooloo, b. apoos, or in Burma waboor, kyellowa, waya, teiwa (*Bamb. Tulda*) and kyattounwa; in Sikkim chiefly pao] are taken with both knots left on them, in one of which is cut a small hole through which the water is poured in and the hole is then closed with bamboo or more usually plantain-leaves. Such water-holding joints are called kélé by the Sundanese, and gunyeh in Malay. It is also the custom with these people to have bamboo-poles of two or three joints, of which the uppermost and median knots are perforated, and filled with water; such are called lodong in Malay. The women and girls can daily be seen, with such water-tubes on their shoulders or (like the Karens) having them sus-

pended by bamboo-strips from their forehead, going down to the wells or river, where they fill these tubes with water for the use of the coming day. The water keeps very well in these bamboo tubes without taking any tang if the holes are well closed. A dozen or so of these bamboo tubes stand usually in the corner of every Malay house, serving not only for cooking and drinking, but in time of need for extinguishing fire. In climbing high hills, or when travelling through tracts poor in water, the drinking water is carried in similar water-pipes. Rice, vegetables, coffee, tea and other food is cooked in similar tubes taken from young, and therefore somewhat succulent halms. Food thus prepared partakes of a particular tang, (that of burnt fresh vegetables), but it is never refused by a hungry stomach. Single joints of bamboo andong, and also of the Sikkim pao, serve also well for small water buckets. Thinner halm joints are cut just below the nodes, and the Indian obtains in this way little tubes, solid below, in which he keeps fluids, honey, sugar, salted fish or fruit just in the same way as we do in bottles or jars. Many a Javanese can be seen on market days carrying home in this tube, suspended from bamboo strings, the oil, etc, that he wants in his little household.

Chinese masons use for white-washing brushes made of thin bamboo slips fastened together and secured in a handle of bamboo. The Malay has similar ones, but beats with a mallet the whole end of a bamboo joint until dissolved into fibres. However pandan air-roots are with him much more in use for this purpose, as they can be beaten more easily into brushes. The small brushes, used in China for colouring pictures, are also made of fine bamboo shavings introduced into a small holder of bamboo. Modellers of the same country use small chisels cut from the hardest part of the bamboo halms, and they are very expert in the use of them for carving plaster and such like soft material.

Also candlesticks are made of bamboo, and I confess they are superior to those that European travellers often take refuge to, *viz.*, empty bottles. They select for this purpose thin bamboo joints, whose hollowness is wide enough to receive a candle, leave the node about the middle and cut the portion

below this node into threes. A stone between these three segments is secured to them by means of bamboo strings and cross sticks, and so the whole furnishes a tripod candlestick, which is less liable of being upset down than the bottle candlestick.

Bamboo enters also the list of the many contrivances by which fire is obtained by Indians. For this purpose quite dry bamboo joints of 2 to 3 feet length are split into twos. The one half of these is furnished in the centre with a longitudinal slit. The interior of the joint is shaved, and the shavings put inside the longitudinal slit and pressed against it by another piece of bamboo. A longer slab of bamboo, sharpened at one side like a knife, is now rapidly and tightly crossed (like a saw) over the hole from which the bamboo shavings protrude and soon ignites them. This mode of obtaining fire is preferable to the many other contrivances in vogue with natives, care being taken that all the material be perfectly dry, and, therefore, old dead bamboo is usually selected for the purpose. Boyle met even pneumatic fire implements of bamboo with the Dayaks in Borneo.

But the ingenuity of the Indian does not end here, for bamboo is used also for making knives. One side (the outer coating of the halm) of a flattened bamboo slab is sharpened, and, owing to the great amount of silica it contains, grass and low shrubbery can be mowed down quite well. Small ones, made on the same principle, are used by the Javanese even for the operation of circumcision of their children. Broader slips of bamboo, especially of those kinds that are very rich in silica, serve as whet stones, the surface being used for this purpose. In small pointed pieces they serve for pegs, and still smaller and thinner even for pins (like the spines of rattans) to the great disappointment and disgust of many a zealous entomologist.

The use of bamboo for pikolan (carrying poles) is general amongst Malays, and even children are fond of appending their load (and were it only a few plantains) to a bamboo stick for the purpose of "pikol," as this mode of carrying is generally called. The bamboo halms are very strong, and can resist loads of 100 to 200 and even more pounds, but if exposed too much to the sun they are apt to crack on account of the heating of the air enclosed in their joints. Smaller pikolans are made

of a shape somewhat like bows, flattened and the edges rounded. These are often more or less ornamentally carved towards their ends. Loads of equal weight are fastened at both ends so as to keep the balance. When a Javanese has only to one side a load which he cannot divide, he appends as much weight (and were it only a stone) to the opposite end; so innate is custom in man. The carrying of such loads has its peculiarities, inasmuch as the carrier hastens in a short pat in consonance with the elastic swingings of the bamboo, taking at the same time advantage of every swing that may lessen his burden. In this way he carries with less exertion a larger load than do the monotonously singing palkee bearers of Bengal, whose poles consist of unelastic wood.* For tent poles the bamboo halms are excellent and generally in use all over India. Sedan-chairs are extensively used in China, and the ordinary ones are entirely constructed of pieces of bamboo fitted together, while two long bamboo poles pass under the chair and project beyond it before and behind. Batons for certain classes of mandarins, too, are of bamboo, as also the well-known chopsticks of the poorer classes in China.

Bamboo is also fitted for yokes of cattle, axles and even springs of the smaller carts. In Java, etc., these carts have a sort of a little bamboo house build upon them with a sort of vestibulum in front, wherein the driver comfortably sits, and often falls asleep without knowing it.

If we have in Europe ugly scarecrows and such like for driving away the flocks of depredatory birds from the young sowings and cornfields, so has the Malay also his own invention for the same purpose. This consists usually of long bamboo halms, at the end of which is fixed a wind wheel (also of bamboo) which is moved by the slightest breeze with an ugly rattling noise which scares away the numerous rice thieves, a small finch called booroong klatten (*Fringilla oryzivora*, L.) and the numerous small parrots that swarm on the ripe rice-fields. This noise is very disagreeable to the ear, and continuously interrupts the stillness of tropical nature. The Javanese often places in various parts of his field numerous

* Mr. Kurz overlooks here, that the bearer effects the reduction of pressure during the upward swing of the bamboo by an increased pressure during the downward swing.—The Editor.

bamboo sticks of this description, from which are suspended pieces of cloth and other light articles, and connects all these sticks with a bamboo or rattan string. The man who keeps the end of this string, in his hand, pulls them from time to time for the same purpose as above. In such cases he almost invariably erects little bamboo houses on high posts in which he is concealed like a spider, keeping the strings in his hand.

Bamboo loops for weeding (see Peal, Journ. As. Soc. Beng., 1872., Pt. I., t. 4. 4) are used by the Nagas as well as by the Malays.

Bamboo joints of the larger bamboos are also used for beehives (see Junghuhn, Java I, p. 180, and Scherzer, Reise der Novara, II. p. 155). For this purpose a closed bamboo joint is used, or more frequently this joint is cut into twos and again tied together by means of strings and horizontally suspended under the roof of the house. A small hole made at one end of it enables the bee (*Melipona minuta*) to enter these hives. It is a very small and harmless bee, but produces handsome wax, used chiefly in coating the figures in sarongs for dyeing purposes.

While the rich have ivory and costly fans, those of the poorer classes are made of slips of bamboo covered with paper adorned with fantastic designs and vivid colours. Hand screens as well as standing ones are made of the same material, similarly constructed and furnished with ornamented paper or silk. The handles and frame work of the Chinese sun and rain umbrellas (payong) are also made of bamboo, and used not only in Japan, China and the Malay Archipelago but also all over Indo-China as far west as Burma.

For walking sticks are the Malayan and Indian bamboos less in use than the Japanese ones, and are derived chiefly from various species of *Arundinarias*. The Japanese pepper canes are well known and come from a species of *Phyllostachys*. Those of *Phyllost. nigra* are very elegant and smooth, but have, like a few others of the small kinds of bamboo, their joints alternately semiterete. Another kind, (sikak take Jap.) botanically apparently not yet known, is mentioned by V. Siebold (who enumerates not less than 33 varieties of Japanese bamboos in the Verhand. Batav. Genootsch. der Kunsten en Wetensch, XII., p. 4-6), which has square halms. Of this M. Ed. Renard gives an account in

the March No. of the Bulletin de la Societè d' Acclimatisation. M. Renard says he met with this bamboo only in the beautiful plains surrounding the large town of Osaka in Japan. It naturally forms a square halm, but the angles are not very sharp. It grows to 30 to 40 feet in height and differs from all the other Japanese bamboos in not having a polished surface to the halms. The joints are rather short and the nodes prominent. It is chiefly cultivated for its ornamental appearance, and the straight halms are used as walking sticks, the root-part being fantastically carved. The thin and very strong lateral branches of bamb. hower and its varieties make handsome pipes. Malays will construct huge hookahs in a few minutes by inserting a small bamboo tube for a bowl, at a sharp angle, into a large cylinder, about 6 inches from the bottom, which contains water through which the smoke passes. Smaller pipes of the ordinary pattern are as easily and quickly made, and often used even by the European soldier in India.

In a small bamboo-box, prettily carved and ornamented, the Dayak of Borneo carries his sirih and lime, which he uses in betel-chewing.

The Chinese have games of dominoes almost exactly like ours. They are formed of small pieces of cut bamboo, arranged, glued together; one of the pieces is painted and shews the numbers in black and red. Toys for children are generally made of bamboo, such as long bamboo-sticks terminated by a wind-wheel which are carried against the wind, also smaller sticks on which are put flowers made of fine bamboo-shavings variously coloured, and even articulated bojazzis, coloured and moved by strings, can be seen amongst these native toys. Cages, often very ornamental, for birds, etc., and large ones for tigers, etc., are also made entirely of bamboo. Weaving shuttles of bamboo, and rakes made of a cross bamboo-pole with handle to which the bamboo-teeth are obliquely inserted, are things of daily use.

The sheaths in which the Malay carries his long-bladed knive (parang) are of bamboo, and often carved. The cigar-etuis made of the halms of bamb. booloo koneng (*Schizo. brachycladum*, var.) of a beautiful golden-yellow colour are greatly esteemed in

Java. Weirs and fish traps, as well as fish-rodes of bamboo, are used everywhere.

Split and shaved thin bamboo is the strongest material for baskets, and excellent baskets, boxes, conical fish-traps, hencoops, etc., are made of it. For fishery purposes are thin halmed species of bamboo in use, and one sort, *viz.*, booloo seroo, has got its name on account of its fitness for this purpose. Large bamboo-mats of various qualities are sometimes made by the Malays, while the sacs for exporting sugar from Java (called kranyangs) are usually made of bamb. doorie (*Bamb. Blumeana*). The large hats, called toodoongs, which the Javanese men and women wear, and which resemble more the half of a huge pumpkin, are a close network of thin strips of bamboo, coloured and varnished all over the outer surface. The shalako, or head-dress which Europeans wear at Saigoon (Cochin China) is likewise made of bamboo. The Bugginese and Macassers of Celebes make also very fine delicately woven caps of bamboo. The Chinese go so far as to make jackets of the lateral branchlets of a small sort of bamboo. These are about as thick as a crow's quill, and are cut into small pieces about ½ inch long, bound at intervals in rows along a silk-thread and connected into square mashes. Chinese dandies like to wear such bamboo-jackets on their person in order to protect their white cotton-dresses of sweat. Like in the Malay countries so in Burma, boxes of a peculiar kind are made of tight bamboo-network, which are lacquered all over and usually coloured red. In these not only substances, but also fluids can be kept safely. Small boxes of this sort generally serve as sirih-boxes, and at the same time also for drinking cups. Those from Palembang are covered with a varnish so elastic that they can be turned inside outwards without causing cracks or being damaged. The natives of Behar employ the jungli bans (*Dendrocalamus strictus*) for making neatly-worked plates, hand fans, etc., which are generally sold in the towns through the whole of India.

Bamboo greatly enters into native music, especially in the Indian Archipelago and China. In every bamboo bush, says Jagor, are hidden the musical instruments for a whole orchester! A sort of Æolian harp is represented by the so-called plaintive

or weeping bamboo (booloo perindoo or booloo menangies). Sir Emerson Tennant chronicles this sort of natural music thus: In the Malayan Peninsula (but also all over the Archipelago, etc.) the living bamboo has been converted into an instrument of natural music, by perforating it with holes, through which the wind is permitted to sigh in the most charming manner. Mr. Logan, in 1847, in approaching the villages of Kandingoo, heard sounds, some soft and liquid like the notes of a flute, and others deep and full, like the tones of an organ. On drawing near to a clump of trees, a slender bamboo, 40 feet in height, was observed; and it was ascertained that the musical tones issued from it, and were caused by the breeze passing through the perforations in the halm. Those which Mr. Logan saw had a slit in each joint, so that each halm possessed 14 to 20 notes. Living bamboo is often similarly perforated. One of the former Governor-Generals of Dutch India (Baron van der Sloet) used to have a large number of these plaintive bamboos near his palace in the centre of the Botanical Gardens at Buitenzorg, Java. Flutes and fifes are easily made of bamboo on account of the hollowness of the halms. The Chinese have two kinds of bamboo flutes. One kind is closed at one extremity, either by a natural knot or by a stopper of bamboo shavings; along this flute holes are spaced out at regular distances, the first being the mouth piece, and the others being opened and shut by the fingers of the player. Another flute resembles the foregoing, but the knot at one end is cut to a slope, and an opening effected as in the flageolet. There is also a kind of Chinese violin called the hyi iëng, and an ugly thing it is. It consists of a 3 to 4 inch long and 2 inch thick bamboo joint closed at its extremity by a tightly stretched snake's skin. To this is inserted a bamboo-handle about 2 feet long, to the upper end of which are fixed the 2 strings resting on a bridge on the snake's skin. A piece of split bamboo is used as a bow. The Jakoons in Malacca make also a sort of guitarre consisting of a bamboo-tube about a foot long, on which are lengthwise strained 3 or 4 strings which rest on small pieces of wax instead of the bridge. A kind of very curious whistle is used by the Chinese for driving away evil spirits, etc. Several holes are pierced in

a piece of bamboo, two of the natural knots being left, one of which offers an opening out in a slope; to each extremity are fastened 2 long strips of paper from 15 to 18 feet in length and 6 to 8 inches wide. A string is attached to a groove made in the bamboo, and when there is a little wind, this curious kite is sent aloft, remaining in the air as long as the wind is strong enough to keep it up. In this position a monotonous whistling is produced, resembling at times the noise of a jet of steam, sometimes the sighing of the wind in trees. The anklong of the Malays is a very agreeable instrument. It consists of a number of hollow bamboo-joints of various but selected length and thickness which are cut out below and hang down from a bamboo-frame. These give various swinging tones and strength, according lead to their size on being beaten with a bamboo-staff. On the occasion of festivities, such as marriages, circumcision, etc., Malays greatly use the green halms of bamboo (especially the larger sorts), and have them put in specially prepared fires. The air enclosed in the joints gets heated, and the joints burst with a heavy report, which varies in strength from that of a pistol to that of a small gun according to the sort of bamboo used—smaller halms being usually added which keep up a continuous rattling and crackling noise.

Some attention has been paid of late to the bamboo as a textile plant. A fibre has been obtained from the halms suitable for mixing with wool, cotton, and even silk. It is said to be very soft, and to take dyes very readily. To prepare it, the stems are cut across at the joints, and boiled in caustic soda for a lengthened period. The liquid is then drawn off, the halms washed in fresh water, and again boiled in a solution of caustic soda until the fibre of the halms has become somewhat soft. The halms are next put between heavy rollers and crushed, and finally carded or combed, after which it is made up into bales for exportation. When we consider the lengthened period and apparently complex process of its preparation, the question naturally arises whether it can be produced in sufficient quantities and at a sufficiently low price to be remunerative. Mr. Teysman, during his travels on the Moluccas, has observed that the women of those islands chew the young halms of bamboo booloo (*Soki-*

2 F

zost. brachycladum) so long until only the fibres remain, of which they weave coarse cloth, bags, and sacs.

Bamboo is in China the principal, if not only, material for paper-making, and was there used as such when our forefathers were still savages hunting the vast forests of Europe. Cut when quite green, it is scraped and cleaned; the thicker shavings are used for stuffing mattrasses and pillows; the finer shavings are macerated in water and reduced to a paste by a special process. This paste is mixed with a certain proportion of isinglass, and sheets of various qualities of paper are manufactured. The unbleached paper is slightly yellowish, but smooth, soft, and of great strength. The shavings of inferior quality are also macerated, converted into paste, then made into sheets and dried. It is mixed with slaked lime to form a substance with which walls are plastered. This bamboo-paper is also made use of to produce a kind of tinder, very much in request with the lower classes in China, especially the watermen. For this purpose paper rolls are lighted, and as soon as the ignition is complete, the burning rol is thrust in a small bamboo tube, which is immediately closed and the flame thus suppressed. When fire is wanted, the burnt end of the paper is kindled by means of flint and steel and the paper burns like ordinary tinder. Blowing on this sharply, once or twice, is sufficient to raise a flame—a result that cannot be obtained with any other kind of tinder.

For defensive works serve especially bamboo dooree (*Bambusa Blumeana)*, a species very similar to the behor bans (*Bambusa arundinacea*). It forms an impenetrable fence on account of its numerous dependent branchlets armed with copious recurved sharp thorns (spiny buds), and such fences are very generally planted round and in the trenches of the Malay fortifications and redoutes. These fences form in war serious obstacles to advancing troops, and have been recognised as such by the Dutch military men who employ at present the same instead of pallisades; for they prove more durable, really quite impenetrable, and against which even European artillery can do little. The same sort of bamboo is also extensively employed for fences round villages in tracts where tigers are uncomfortably numerous. The so-called rangyoos are thin bamboo pegs sharpened at both ends

which are put in oil and slightly burnt in fire. Such pegs are put vertically in the ground hid in grass. They cause very dangerous wounds, and, in wet weather, can penetrate also the moistened soles of shoes. In the campaign of the Dutch against the Boogginese of Boni (Celebes) in 1859, the Dutch soldiers all carried bundles of such rangyoos, but the Boogginese were not such fools as to run into them, nor hadt he Boogginese rangyoos any effect upon the Dutch troops. Similar bamboo-pegs, prepared in the same way, are used in time of war by all the Malayan tribes and also by the hill-people of Assam and Burma. Against cavalry similar, but much larger, and more solid rangyoos are employed, either placed singly and obliquely in the ground amongst high grass, or more usually crosswise and tied with strings forming thus the so-called spanish riders or chevaux-de-frise. It is a very common custom with Malays and Burmans to place strong bamboo-poles across paths in long grass or dense jungle, fixing them firmly at the one end while the bamboo is tightly strained and fastened at the other end in such a way that it immediately unbuckles as one steps on it or only uncautiously touches the pole, thus striking with all force against the legs of the passers by or the passing enemy. The people of Arracan and Tenasserim have, for catching tigers, a similar method. The bamboo-pole is then vertically planted in the ground and strained downwards by means of a strong rope terminating in a large noose arranged so that the tiger, which preys upon a bait laid for him, must pass and touch the noose, when, of course, he is at once launched into eternity. Blow-pipes (sumpitan, mal,) consist usually of 2 bamboo-tubes of 7 feet length by ¾ inch broad, stuck one into the other. The inner opening is about ½ an inch in diameter. The arrows, ussually 7 inch long, are made of various material, chiefly of the nerves of palm-leaves, wood, or the halms of coarse grasses, rarely of bamboo, and poisoned : they are kept in bamboo-quivers. Most of the savages and independent tribes of tropical Asia still use spears, the shafts of which are of bamboo, javelins, etc. In Java they use for catching thieves, a curious instrument. It consists of two bundles, as thick as an arm, of the lateral thorny branches of the bamboo dooree, which are fastened

fork-like at the end of a bamboo-pole; with this fork they try to catch the person from behind at the neck. As the thorns are all reversed the captive cannot easily escape. In every watch-house along the roads and in the villages of Java this sort of instrument is in general use, and the Javanese are very expert in its use.

The uses of bamboo, however, are not only restricted to technical purposes, but bamboo furnishes also a share in Indian cookery. The young shoots (called rebong in Malay) just when they burst from the ground like gigantic scaly horns, are a favourite vegetable with the Malay and Chinese. Most of the larger sorts, as bamboo bitoong, wooloong, andong, atter and more especially b. kriessik, yield edible rebong, while those of the small kinds are used little, being often are of a bitter taste and therefore not edible. These rebongs are cleaned of the sheaths and of the numerous stiff hairs (which act irritating upon the skin,) cut into small pieces, and, with other additions and seasoning, form a well-known Malay vegetable (sayor rebong). Pickled they form the atsyar, which is frequently exported. In China are also used the shoots of the smaller sorts, while about 6 to 7 inches long and as thick as one's finger. They are of a very fine light yellow colour, are very tender, and but slightly stringy. Sometimes they are boiled in water, a little salt being added, and resemble then asparagus. They are eaten not only by the Chinese, but also by foreigners sometimes with oil, or with white sauce, or cut in small pieces as salad, or more usually made into the more liked "poison gratiné au bambou." A more important rôle play the seeds of several species of bamboo (usually called by the natives "bamboo-rice") in years of scarcity in India. These resemble somewhat oat-grains, and the yield of a stock of bamboo is enormous. At the same time there is a remarkable tendency in bamboo to flower and fruit in unusually hot and dry seasons when famine and scarcity are the usual concomitants. The seed contained in the hard fleshy pericarp of *Beesha baccifera*, the "berry" bearing bamboo, is a pleasant eating, being not at all austere, though without much flavour. The Arracanese declare also the pericarp edible after baking. The leaves are much in use as fodder for cattle in regions where

meadows or o her grass are scarce or wanting as in the Sikkim Himalaya. Such was the case for a long time on the Andamans, where pastures are entirely wanting. The young shoots, like the plantain stems, are a most favourite food of the elephants.

In native pharmacopœa we find the water, which often accumulates in the bamboo-joints, especially of very hollow kinds, used against bowel-complaints, with what success I cannot say, but all I can add is that this water in the bamboo halms, like that found in the pitchers of the *Nepenthes*, has often quenched my thirst during my tours in the Java hills. Numerous other medicinal virtues are ascribed to various parts of the bamboo by Loureiro (Flora of Cochin China), and by Father Blanco, in his Flora de Filipinas, but hardly worth mentioning here. The stiff fragile very fugaceous hairs or rather bristles on the sheaths of the shoots are used for poisoning. They are put in the meal, or more usually in the coffee to be partaken, and are said to cause death, not suddenly, but the action is very slow and the victim succumbs only after many months. Tabasheer is a siliceous whitish floury substance which is found as a secretion, or more probably as a residuum in the interior of the joints of several species (especially *Bambusa arundinacea*) often up to an inch in thickness. It is employed in Western India to cure paralytic complaints, and as a stimulant and aphrodisiac. In China, it plays a great rôle in Chinese medicine, and pretty large quantities of tabasheer are exported especially from India to that country and Arabia. Tabasheer is also used in polishing, a quality it owes to its silicious composition.

Noteworthy is the great amount of silica of most of the species of bamboo, which is so great that the ash of burnt bamboo-halms shews distinctly the silica-skeleton of the structure. This amount of silica, however, varies greatly in one and the same species, as for example in bamboo tamyang of which the one of its varieties (bamboo tamyang sonoh) turns so hard that sparks are emitted from the halms when cut with the parang.

For religious purposes, the bamboo furnishes in the Philippines churches, chapels and crosses. For educational purposes,

says F. Jagor, is the rattan far more in vogue, and is vigorously resorted to, so much so that a Philippine proverb says: There sprout a thousand rattans in the jungles for every Indian born. The Chinese cut fantastically-shaped figures from the knobby rhizomes for their temples and house-altars. The peculiar throw-pieces, used in the Chinese temples for auguring the success or failure of an undertaking according to the nature of the fall, are also made of bamboo.

For ornamental purposes and landscape gardening, bamboo forms one of the most picturesque features, of which especially the Chinese understand to make full display of it in their rockeries, etc. This effect is still more enhanced by the gaudy glossy colouring of the halms of many species, and the varieties of bamboo hower and leleba, as well as those of booloo along with the black-stemmed species of Phyllostachys of China and Japan, are more especially noteworthy in this respect, and ought sooner or later come into general use in the South European gardens. Indeed in Italy bamboo is already much in cultivation in the open air, but the night frosts and occasional snow falls will always form a great obstacle in their open air culture in Europe. Mr. E. B. Fenzi of Florence has given notes in the *Gardener's Chronicle* for 1872, pp. 1228—1229, on the species (or rather varieties, some of which are however enumerated twice under other garden names) that are cultivated and hardy in Italy.

I may now conclude with alluding to a fearful penal punishment, formerly in use in Bali, for the publication of which Dr. F. Jagor must be made responsible. He tells us that the criminal was strained horizontally over the young growing shoots of a bamboo stock, of which the longer halms have been removed. As these grow very rapidly the very hard silica-rich (?) shoots pierce through the unfortunate sufferer.

This resumé of the uses of bamboo, although still meagre, may yet remove any surprise on our side when reading in Rumphius' Amboinsche Kruidboek, IV., p. 13, that the Radjahs of Boutan (Moluccos) were proud in asserting that their forefathers sprung from the womb of a bamboo.

II.—General habit and growth of Bamboo.

However great the number of the species of bamboo may be, they all agree in general habit, so much so that one rarely can confound them with other plants. Those majestic forms that grow up to a height of 90 to 120 and even more feet, impress the mind of the new comer as much as the palms and plantains, and where they associate into forests they usurp the whole terrain and expel all other plant forms; they form a highly homogeneous physiognomy, but still agreeably influence the human mind. They equally combine vigour and elegance and almost always form a strong but attractive contrast with the surrounding vegetation. The distichously branched halms rise, like gigantic plumes, to a great height, lovely bowing outwards in graceful arcs towards their ends. The stiff and rigid halms, moved by the wind, impatiently rattle and melancholically sigh, while the dry harsh foliage rustles through the forest. Between the majestic old colossal columns of bamboo, one wanders through these dark arcs often hindered in the progress by fallen or rotten halms. In these vaults a peculiar uneasy twilight prevails, and one cannot dismiss the thought that the whole forms a natural Gothic church. Nothing is more impressive and melancholically beautiful than a cemetery in a bamboo-grove, as one can verify for himself in visiting the cemetery of the Governor-Generals in the Botanical Gardens at Buitenzorg, Java.

Such is the general impression that larger bamboos effect upon the mind of man, but there are gradations, and as we go northwards and enter the more temperate zones of our globe we meet with smaller and smaller kinds, until they dwindle down to mere undershrubs, when they little differ in aspect from other grasses.

Most, if not all, bamboos, are eminently gregarious and form jungles for themselves, or the undergrowth of high forests. If individuals occur also singly or few together, they are stray ones, and their species will be found in one or the other locality in quantity.

The bamboo, full-grown, forms usually a more or less developed stock, sometimes up to 3 feet high, formed chiefly of old

trunks of the dead halms and an entanglement of roots, from which 10 to 50, and even up to 100, halms arise of the thickness of one's arm to that of a human thigh, often attaining upwards of 120 feet in height. There grows also a species in Tenasserim of which the halms are said to grow singly from the stock, and which for this reason is called tabein-dein-wa.

The halms are branchless or furnished only with small very inconspicuous branchlets, either up to ⅔ of their whole length, and then they possess a columnar appearance (bamboo wooloong, bitoong, andong, atter) or they are furnished already from the base or from the middle with whorls of branches arising alternately or rarely (mostly only abnormally) in an ⅓ arrangement; also in this case the halms are still well visible, as for example in bamboo hower, booloo, etc. Most species of *Schizostachyum* are characterized by the crowdedly placed halms of only one to a few inches thickness, which become quite hidden from view on account of the numerous drooping branches, and hence they resemble from a distance more to gigantic hemispherical shrubs. Low shrubby species are rare within the tropics, and I know only of two, *viz.*, the lelebas of the Moluccos, and booloo akkar (*Schizost. chilianthum*), a Sumatran species. On the other hand, by far the greater part of the *Arundinarias* (which all possess only 3 stamens) are shrubby and restricted to the higher regions from about 5,000 feet upwards, while in higher latitudes, in China, Japan and the Kuriles, they descend to the plains and differ not in espect from other grasses. Of truly scandent bamboos I may mention the few species of *Dinochloa*, of which tjangkorreh of the Archipelago climbs into the loftiest trees up to 100 feet, and wa-nway (*Dinochloa Maclellandii* and *D. Andamanica*) are not less lofty, often hanging down with their ends from the loftiest trees in numerous festoons. The species of *Pseudostachyum* are half scandent and arching bamboos.

The shoots, which protrude from the earth at the beginning and during the period of the rainy season, and especially the sheaths that cover them, furnish the best distinguishing marks of nearly allied species when out of flower; these marks are most constant in the same state of development, and hence are invariably relied upon by natives, not only of the Malay countries

but also of India generally. These shoots first appear as scaly cones, or to speak with Rumphius, as curved horns (rebong, mal.; gora, Beng.—see plate I., fig. 1), and in this state they are fleshy and often edible when cooked. They are quite covered with imbricating sheaths, variously clothed with stiff fragile deciduous bristles which easily penetrate the skin and cause much irritation. Further developed, when the joints of the halms become visible, they are called siroong by the Malays, and it is in this stage of development that the differential characters are most conspicuous and can be studied to the best advantage. The sheaths attain their fullest development, and consist now of the sheath itself, the imperfect blade (corresponding to the leaf of the developed plant), the auricles which are usually only the decurrent often thickened base of the imperfect blade continuous with it, or these auricles are rarely not developed at all, and finally the ligule, a membraneous, broader or narrower, entire or fringed membrane which inside fringes the junction of the sheath with the imperfect blade. All these parts, as already noted, are of special importance, and variation of the same takes place only within certain limits of the species itself, and more especially with reference of the development of the sheath; all matters which must be studied in nature, and which, once recognised, greatly facilitate the recognition of bamboo species. In some species of *Phyllostachys* (*Ph. nigra*) the shoots creep as rhizomes a long way under the ground before their ends come to day, and at the same time they send out lateral shoots from their joints at certain distances which similarly burst from the ground, and finally grow out into dense shrubs. This species, therefore, covers in a short time large areas by this process, and it is often difficult to check its spread.

The sheaths, with which the branch-shoots are protected, generally agree in shape and indument with those of the halm-shoots, and more especially in the imperfect blade, but are very differently shaped amongst themselves according to whether they are taken from the lower or upper parts; hence they are less recommendable for the discrimination of species, although they may serve as such in the absence of halm-shoots.

The rapidity of growth of bamboo-shoots has been com-

mented upon by several observers. The mean period of growth of bamboo-shoots, during which they attain their full height (30 to 90 and even 120 feet) but not their development into branch whorls, etc., oscillates between 2 and 3 months. Until they have reached their full height large developed leaves appear only on the extremities, and it is only at the period when induration or rather silification of the still soft halms begins that the development of lateral branches fully takes place, commencing in most species from below upwards.

Much has been written about the rapidity of growth, and more especially regarding that of bamboo grown in European stoves. Thus in the hothouse of the Botanical Gardens at Glasgow it has been ascertained to rise one foot in 24 hours. Inspecteur Bouché of the Botanical Gardens at Berlin measured a bamboo (said to be *B. verticillata*) from the 24th June to the beginning of October, and gives 38 feet as the height reached. From 28th June to 4th August it was daily measured, and grew 10 feet in 38 days, thus 3½ inches per day, but during some very warm days 7 and even 9 inches. Several other notes on this subject may be found in the pages of the *Gardener's Chronicle*.

However, we have to do here chiefly with the growth of bamboo in their native state, and I regret to say that the measurements at our disposal are not so satisfactorily as they should be. I give here the accounts of them as far as I am acquainted with them, letting follow my own measurements which I made many years ago.

The first measurements of the growth of bamboo-shoots were made by a native Mohamedan gardener, Mooty-Oollah, under the superintendence of Dr. Wallich, in the Botanical Gardens at Calcutta, and communicated by the latter to Prof. V. Martius.* They are not accompanied by any data of temperature or weather or anatomical researches, but still interesting as far as they go.

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* V. Martius Ueber das Laengenwachsthum der Bambu-Schoesslinge. (Bulletin of the Roy. Academy of Sciences of Munich, No. 33, May 12th, 1848.)

Increase in length in English inches.

Date.	Bambusa gigantea, Wall.		Bambusa Balcooa, Roxb.	
1833. July.	Morning.	Evening.	Morning.	Evening.
1	3·00	3·25		
2	3·00	3·50		
3	4·00	4·50		
4	4·00	3·00		
5	5·00	3·50		
6	4·00	3·50		
7	4·50	3·50		
8	4·50	6·00		
9	4·00	5·50	1·25	1·00
10	3·50	6·00	1·50	1 25
11	5·00	5·50	1·50	1·25
12	5·00	6·00	1·50	1·75
13	5·00	5·00	2 00	2·25
14	5·50	4·50	2·50	2·75
15	4·50	5·00	2·25	2·75
16	5 50	5·50	3·00	3·00
17	6·50	5·50	3·25	3·00
18	6·50	7·50	3·50	3·00
19	7·50	6·00	3·25	3·00
20	5·50	5·50	3·00	3·00
21	7·50	7·00	4·25	4·00
22	7·50	7·00	4·25	4 00
23	6·50	7·00	4 00	3·00
24	7·00	6·50	3·50	4·00
25	6·00	7·50	4·25	4·00
26	5·25	5·00	4·25	4·00
27	5·00	5·50	3·75	4.25
28	3·50	5·50	4·25	4·00
29	3·50	5·50	4·50	4·25
30	3·00	2·50	3·75	3·75
31	2·00	2·00	4·00	4·00
Total	149·75-inches.	159·25-inches.	73·25-inches.	71·25-inches.

This gives for *B. gigantea* a total increase in height of 25 feet 9 inches in 31 days, and shews a difference of 9½ inches in favor of the growth during day. Bamb. balcooa grew during the 23 days 12 ft. ½ inch with 2 inches in favor of growth during night time.

Increase in length in inches of Bambusa "Tulda," Roxb., Basni bans.

Date	Shoot. A.		Shoot B.		Shoot C.	
1833. June.	6 a.m	6 p. m.	6 a. m	6 p. m	?	?
25	2·75	......	3·00	......	3·25	......
26	......	8·00	......	6·50	8·00	......
27	3·00	4·00	3·50	3·00	2·75	......
28	3·50	3·00	3·75	3·75	4·00	......
29	3·00	4·50	2·75	4·50	3·50	......
30	3·75	......	4·00	......	......	......
1st July	3·00	......	2·25	......	......	......
Total in 7 days, 38½ inches.		Total in 7 days, 37 inches		Total in 5 days, 21¼ inches.	

The above bamboo is called by Wallich *Bambusa Tulda*, Roxb., and the native name given for it is bansni bans. There must be some mistake, for basini bans of the Bengalees is *B. vulgaris* according to my own researches, while tulda bans of Bengal is *Gigantochloa auriculata*. The shoots A. B. C. are described as follows: shoot A., a slender one, measuring on the 1st of July 1833, thus at the close of the observations, 4 feet 8 inches in length and 4¾ inches in circumference, with 20 joints, each with its leaf-sheath; shoot B., which had on the 24th June 1833 a circumference of 4¾ inches with about 20 joints and sheaths; and shoot C., of which no particulars are given.

Other measurements are given of two shoots of *Melocanna baccifera*. They shewed the following increase in growth:—

First Shoot.		Second Shoot.
1st to 7th August 1873	... 1 ft. 8 in.	1 ft. 6 in.
8th to 14th " "	... 2 " 2 "	1 " 8 "
15th to 21st " "	... 2 " 11 "	2 "
21st Aug. to 28th Aug "	... 3 "	2 " 6 "
Total in 28 days	... 9 feet 9 inches	7 feet 8 inches.

Dr. Roxburgh observes, that the shoots of his *Bambusa Tulda* rise to their full size, from 20 to 70 feet in height and from 6 to 12 inches in circumference, in the course of about 30 days. Dr. John Davy measured a bamboo-shoot6 days successively, one that was about 4 feet from the shoal from which it sprung. During the first 24 hours it increased in height 6·75 inches; during the second, 5·25; during the third, 4·5; during the fifth, the same; during the sixth, 4·5 inches. These observations were made between the 22nd and 29th September, and on a plant in a comparatively poor and dry soil. Mr. Fortune, who has made numerous measurements in the Chinese bamboo jungles, found the growth from 2 to 2½ ft. in 24 hours, and he found also (like myself) that the growth is greatest during the night.

I will now give the tabular results of measurements of 2 gigantic species of bamboo, *viz.*, *Gigantochloa robusta* (bamboo wooloong) and *Gigant. atter* (bamboo atter) which I obtained in 1862 in the Botanical Gardens at Buitenzorg, Java. The garden is situated at an elevation of between 940 to 960 ft. english. The measurements could for several reasons be commenced only after the shoots were much developed. As they represent only single observations they can have only relative value and thus represent only approximately the real nature of growth. However the measurements themselves were executed with all care, but the correct readings became more difficult with increasing height of the shoots, and therefore the measurements were carried on only during the first month. As the tips of the imperfect blade were taken as the extremity, it necessarily happened that periodical retrogrades in length appear in the table. They are caused by the spreading of the blade at a certain stage of development. Such retrogrades are marked in italics. Measurement of the increasing length of the internodes themselves, comparisons of such measurements, and the anatomical changes in the inner structure of the halms I reserve for a future revision of Indian bamboos.

The measurements are in French mètres, and I have not thought it necessary to reduce these to English equivalents.

The temperatures were taken by Dr. Schwarz, at the time Civil Surgeon of Buitenzorg, according to the medical usage, *viz.*, at 9 a.m., 1 p.m., and 10 p.m., and thus are barely of value for agricultural and physiological purposes, for reasons which I have given already in my report on the Pegu Forests (page 87.)

The height of the shoots of the 2 bamboos measured on the evening of the 16th December 1862 was the following: that of *Gigantochloa robusta* was 0·64 mètres; that of *Gig. atter* only 0·11 mètres.

The plantain gives much smaller values of growth in length as compared with bamboo, but in reality grows quicker than the latter, for here the lengthening takes place throughout the whole of the axis, while in bamboo it is of a double nature, lengthening of the joints themselves and production of new joints. In the plantain, moreover, the growth is very unequal and increases from

outwards to the centre. This can be very plainly seen in cutting through a plaintain stem, when we see the next day the central part, (the young leaf) protruding far above the outer concentric layers (leaf sheaths) the latter shewing gradually less vigorous growth according to the age of the leaves.

Table shewing the growth of a shoot of bamboo wooloong and bamboo atter in the Botanical Garden, Buitenzorg (Java) in 1862-63.

DATE	GIGANTOCHLOA ROBUSTA.		GIGANTOCHLOA ATTER.		Mean Temperature lelsius.	WEATHER.
Dec. 1862.	6 a.m.	6 p.m.	6 a.m.	6 p.m.		
17	0·0255	0·0101	0·0070	0·0150	24·5	Oppressive, somewhat rain towards eve.
18	0·0410	0·0175	0·0115	0·0120	24·8	Changeable, no rain.
19	0·0190	0·0190	0·0040	0·0150	25·1	Rainy, somewhat rain at eve.
20	0·0110	0·0290	0·0075	0·0105	24·9	Changeable, with rain.
21	0·0310	0·0171	0·0090	0·0065	24·8	Rain with interruptions.
22	0·0245	0·0150	0·0040	0·0080	24·4	Cloudy, but no rain.
23	0·0247	0·0132	0·0095	0·0120	24·1	Cloudy, but no rain.
24	0·0251	0·0140	0·0145	0·0125	25·4	Cloudy, with rain.
25	0·0171	0·0145	0·0280	0·0092	25·0	Cloudy, soon plenty rain.
26	0·0315	0·0173	0·0150	0·0097	24·0	Rain all day.
27	0·0345	0·0190	0·0181	0·0103	24·7	Rain all day.
28	0·0400	0·0165	0·0215	0·0125	24·0	Changeable, with rain.
29	0·0390	0·0185	0·0225	0·0115	24·1	Changeable, without rain.
30	0·0410	0·0240	0·0270	0·0150	24·7	Cloudy, clearing up; rain during night.
31	0·0645	0·0381	0·0321	0·0225	24·3	Rain all day.
Jan.						
1	0·0735	0·0301	0·0360	0·0221	23·7	Rain all day.
2	0·0736	0·0363	0·0525	0·0215	23·3	Rain all day.
3	0·0715	0·0465	0·0515	0·0375	23·8	Rainy.
4	0·0742	0·0291	0·0588	0·0350	24·5	Fine and clear.
5	0·0820	0·0323	0·0690	0·0430	24·5	Fine and clear.
6	0·0987	0·0585	0·0835	0·0645	24·5	Fine and clear.
7	0·0841	0·0852	0·0901	0·0700	25·0	Fine and clear.
8	00·481	0·1350	0·0881	0·0675	25·0	Fine; rain towards eve.
9	0·0847	0·0591	0·0355	0·0461	25·3	Fine; rain at midday.
10	0·1625	0·0710	0·0570	0·0501	24·7	Rainy.
11	0·1025	0·0520	0·0660	0·0411	24·7	Changeable, with little rain.
12	0·1231	0·0701	0·0810	0·0510	25·1	Changeable, some what rain.
13	0·1875	0·0700	0·0775	0·0491	25·0	Rainy.
14	0·1385	0·0747	0·0630	0·0453	24·9	Cloudy, without rain.
15	0·1265	0·0770	0·1252	0·0510	24·5	Rain all day.
Total of growth	1·9554 Nocturnal	1·2097 Diurnal	1·2659 Nocturnal	0·8770 Diurnal		
Total of growth in 30 days	3·1651		2·1429			
Total height of shoots on the 15 Jan.	3·8051		2·2529			

From the above table we may be allowed to deduct a few general facts. The growth of a bamboo-shoot is increasing in the proportion as more joints are developed. The greatest activity of growth takes place during night and during fine clear days. Both these latter conclusions are not settled as yet, for serious aberrations from this rule take place which can be explained only by longer and repeated measurements, and such, no doubt, will cause considerable modifications of the above deductions.

On the 15th February, thus a month later, the total height of the same shoot of *Gigantochloa robusta* amounted to 9·75 mètres, and that of *G. atter* to 6·24 mètres, so that the former's growth during this period was 5·9449; that of the latter 3·9871 mètres. Only on the 2nd March, *G. robusta* began (then 24 mètres high) to form lateral branches; while *G. atter* did so by a height of 7 mètres on the 30th March. I must mention here that the development of lateral branches regularly takes place from below upwards, and in these two species before us the little meagre lateral branchlets that arise from above the lower nodes appear very early, while the larger ones of the last third part of the halms appear often only when the lowermost ones have already long dried up.

The rapid growth of shoots, however, continues only so long as the halms are pretty soft and porous, *viz.*, the cells very large and loose, but it is checked as soon as the lateral branches become more developed, and the consistence of the halms becomes denser on account of the rapid formation of smaller cells, woody vessels and silification. Arrived at this stage no important change takes place either in the height or thickness of the halms. I must also remark here, that these shoots often, and in certain species regularly, overtop the fullgrown halms of the preceding years and give thus a peculiar but elegant aspect to the stock. This elongation is due to two causes: first, the halms of some of the species become with maturity more spreading and overhanging, and thus appear shorter than they are; and, secondly, the height and strength of the halms increases with the age of the stock, and hence the young but fully developed shoots naturally will be the longer and stronger ones.

The number of shoots that every bamboo-stock annually pro-

duces varies greatly according to the species, and even according to the strength and vigour of each individual bamboo. The larger kinds, however, produce yearly between 12 to 20 and sometimes more shoots; some of the smaller bushy kinds as much as 20 to 50. But some of the shoots lose, for some reason as yet unknown to me, all their vitality at a very early stage, when they just have burst from the ground, and quickly die off. Hence we see so often such dead shoot-cones on most of the stocks. But even the number of shoots-yearly produced, as given above, is enormous. If we assume, say only 10 per stock a year, we should get as many as 300 halms to the stock in 30 years, which is the mean age of most of the bamboo-species at which they begin to flower and die off; while 50 and fewer halms to a bamboo-stock is a very dense growth even in those primeval forests where the axe of man does never touch them. However the many dead halms that one observes in a stock fully explains the comparatively small number of halms left. Still the explanation as to the real cause of the dying off of otherwise well-developed halms, which probably do not even come in flower, is not such an easy one, unless we assume that a greater number of halms is produced than the stock can nourish, in which case the less vigorous halms would succumb more or less slowly according to circumstances.

There exists a belief amongst natives that a thunderstorm is necessary before bamboo can shoot out. This belief is less fostered in the Malay countries than in British India, probably on account of the greater frequency of thunderstorms in the former regions. Captain W. H. Sleemann writes (Trans. Agr. Hort. Soc., Ind., IV., 190):—"In the rains of 1835, my bamboos at Jubbalpore had not thrown out their shoots at what I considered the usual time, and I asked my gardener the cause. He replied, we have had no *thunder* yet; as soon as the thunder comes, you will get shoots. I asked him what possible connection there could be between the claps of thunder and the shooting of the bamboos. God only knows, said he, but we know that till the thunder comes, the bamboos never shoot well. The thunder came, and certainly the gardener's theory seemed to me to be confirmed by a very steady and

abundant shooting of the bamboos. Here possibly the cause rests in the increased amount of nitrogenous compounds absorbed with avidity through the humus that accumulates round the bamboo-stocks. Repeated cutting of too many bamboo-shoots considerably weakens the stock, while the cutting of full-grown halms does not more injure them than the mowing does the grass. Indeed it is believed that too much cutting of shoots results in early flowering of the stock itself and such means in most cases death to the whole plant.

The halms of the same species vary very much as well in their height as also in the nature of their surfaces and color. Usually they are cylindric with or without prominent knots. Only a few of the small kinds (chiefly Japanese and Chinese *Arundinarias*) form an exception and possess alternately semi-terete or even 4 cornered halms (see v. Siebold, Verh. Genootsch Batav. XII. 6). A furrow or flattening on the inner side of the halm-joints where ramification takes place, is present in most species. As regards the height which bamboo attain, halms are known of 140 to 150 feet in length, and Zollinger measured a bitoong-halm (*Gig. aspera*) of 170 feet. The usual height of the tallest species (as bamboo bitoong, andong, wooloong, wabo, etc.) varies between 90 to 110 feet. The thickness is in proportion of about ⅓ feet in 50 feet and oscillates between that of a man's arm to one foot or somewhat more. According to a communication of Mr. Rigg of Jasinga (Java) there were, at the exhibition of 1853 at Batavia, samples of bamboo-halms from Daya Loohoor in Banyoomas which had a circumference of 25 inches at the base, and at a height of 118 feet they still measured 22 inches in girt. On the other hand, we have in Japan and the Kuriles pygmaean bamboo of only 4 to 6 inches in height, the halms of which attain hardly the thickness of a crow's quill. These are often, as in ginmeitsik, almost solid.

The durability of the bamboo-halms depends chiefly upon the thickness of the wood and upon the amount of silica it contains. The surface of the halms is either quite smooth and glossy of various colours, as green (bamboo hower gullies and booloo idyooh), or glossy yellow (bamboo hower konneng

and booloo konneng), or beautifully striped yellow and green (bamboo hower seh-ah); or in the greater number of species more or less rough and of a greyish green, greenish yellow, blackish green and even purplish-black colour. Sometimes they are striped dull-yellowish and green, but also (as in leleba soorat) striped with whitish yellow and rose, or (leleba tootool) similarly blotched; very rarely, as in a variety of the China bamboo (*B. nana*), occasionally orange coloured. The surface of bamboo bitoong and the Burmese Kyattounwa (*B. Brandisii*) is covered all over with a roughish greyish or dirty yellowish-grey felt easily scraped off. This felt becomes sometimes rusty or even golden-coloured below the prominent nodes. The yellow halms of booloo konneng are covered with a white fugaceous meal, somewhat resembling that which covers the inner walls of the joints; other species, like *Dendrocalamus giganteus* and booloo idyooh have them white-pruinous. Bamboo tamyang sonoh owes its greater roughness and grey-green of its halms chiefly to the unusual percentage of silica it contains.

The knots form transverse solid septa in the interior of the joints, but a remarkable monstrosity of a bamboo-halm (species unknown) was sent many years ago to the Museum of the Botanical Gardens, Calcutta, which virtually has all the knots united into a perfect continuous spiral. The portion of halm sent is about 7 feet long, and as thick as an arm, but not equally thick and abruptly bluntish at the end; the windings of the spiral are from the right to the left (the axis considered in the spiral.) In plate 1, fig. 2, I have given a figure of the lower portion of it, very much reduced in size. Another monstrosity of halms has been brought home by Dr. J. Anderson from the Khakyen hills east of Bhamo (so I believe for there is no label to it), which has the joints remarkably inflated, and this may possibly be rather the result of artificial training. Also of this will be found a piece (natural size) figured on the same plate fig. 3. The original halm is 2½ feet long, the joints at the narrower part 6 lines in diameter and at the most inflated parts they measure 7½ lines.

Bamboo bitoong, the Burmese Kyattounwa, and several

other tall species emit short (up to $\frac{2}{3}$ inch long) densely packed aëral roots round the knots up to $\frac{2}{3}$ of the height of the halms; similar garlands of roots, but less developed, occur also on the basal jointings of other species (bamboo andong, atter, ietam, wooloong, etc), especially when they attain a certain age, and these rootlets usually penetrate into the soil and derive from it additional nourishment for the halms. The aëral rootlets dry up soon and encircle the nodes with a garland of somewhat spiny coarse fibres, and hence the halms of several species of bamboo are described by some authors as being "spiny." Strictly spoken there is no such thing as true spines in bamboo, for such spines are either the dried-up aëral rootlets just spoken of, or (as bamboo dooree and the Bengalee behoor bans and a few other sorts) the recurved spinescent buds which either become arrested in their growth or more usually develope themselves into branchlets during the subsequent year.

The branches and branchlets arise always close to the jointings in half-whorls or clusters, rarely by 3 or 5, and still more unfrequently singly, as for example in leleba. The centre-branch is usually longer and stronger than the lateral ones. In Wapyoo geley (*Gigantochloa albo-ciliata*) it becomes as thick as, and occasionally even thicker than, the halm itself, while the lateral branchings use to be shorter and less ramified, or sometimes become altogether arrested in their growth. These branch-whorls arise invariably alternately from the nodes and thus appear distichous, very rarely and usually only abnormally, they are arranged in an $\frac{1}{3}$ position. The halms would therefore have a very simple plume-like appearance, as is really the case with some sorts of bamboo, but the repeatedly alternating lateral branchlets now placed in half-whorls, now singly or only few together, spread in all directions and thus give a more massive aspect to the whole. Their length is various and partially conditions the general habit of a bamboo accordingly that the branchings arise from the upper or lower portions of the halms. In bud they appear either as soft, subulate, long-tapering cones (in fact these are shoots in miniature of a secondary, tertiary, &c., order), of a more or less

spine-like aspect, or, as already mentioned above, as curved spines placed by 3 to 5. They are similarly like the radical shoots protected by many scale-like sheaths, which in a certain degree resemble the shoot-sheaths and which enlarge with the development of the branches. They usually fall off very late and are still seen at the flowering period.

The leaves of bamboo are all distichously placed just as is the case with all true grasses. They are more or less narrowed or constricted at the base into a short stalk (nearly in all species), or very rarely almost sessile and nearly half stem clasping as in a few varieties of leleba. The petiole is jointed to the sheath, a characteristic peculiarity of bamboo generally, and foresters may take this point as a distinction between bamboo and other grasses; for only very few other grasses shew this same peculiarity. The leaf-stalks of *Phyllostachys kumasasa* from Japan have been described as jointed, but more close examination has shown that this is not the case, and that those parts which were mistaken for the petiole are in reality shortened joints of the lateral branchlets, from which the lower leaves have fallen or were never developed. The leaves are usually very variable in shape and more particularly in the nature of their base. Often enough occur two and even three differently shaped leaves on the same halm, the lowermost ones arising from the meagre reduced branchlets, and the uppermost ones which are usually very much larger than all the rest. So for example are the leaves of the basal branchlets on the halms of bamboo hower and more especially of its variety bamboo hower tootool, small linear, smooth and yellowish green, while those of the branchlets higher up the halm become nearly $1\frac{1}{2}$ feet long dark-green and almost roughish on the upper surface. The number of the primary and secondary nerves must needs vary in proportion to the size of the leaves. I could bring forward numerous examples that would demonstrate how little value can be attached to the size, shape and nervature of bamboo leaves. Also their consistence, hairiness and roughness depends more or less upon the age of the leaves or of the bamboo-stock. Densely crowded bunches of sickly looking yellowish green leaves sometimes depend from the ultimate branchings which remain almost

herbaceous; but more frequently still the leaves do not come at all to perfection, and the branchlets in this case are multifariously curved and simply sheathed. Both these two sickly and abnormal states are not rarely accompanied by subulate fleshy black excrescences of the end-buds caused by a fungus, and such monstrosities are often mistaken for bamboo fruits, not only by Europeans but also by natives.

The colour of the leaves is usually a dark green on the upperside and beneath a somewhat paler green verging into grey, turning really greyish green in drying. Some species, like *Bamb. nana, Teinostachyum Griffithii, Gigantochloa macrostachya,* etc., have the leaves quite white beneath, others greyish green on both sides, but only very few enjoy a yellowish green colour. Striped (white) leaves occur in some cultivated Japanese and Chinese bamboos.

Bamboos are of two sorts, *viz.*, the leaf shedding or deciduous, and the evergeen ones, the latter class being chiefly represented in damp climates, along river sides, or in the shade of tropical forests. Deciduous bamboos, however, like yakatwa, jungli bans or male bamboo (*Dendrocalamus strictus*) etc., become often evergreen in damper climates, or when they grow in moister localities. On the other hand, bamboo normally evergreen, (such as kyattounwa, wapyoo geley, etc., etc.) become regularly leafshedding in drier climates or in arid localities, or become so temporarily in unusually dry seasons.

The sheaths of the leaves would offer good characters in the discrimination of the species of bamboo, if they would not loose so very readily their auricles and clothing when full grown, and some practice is therefore necessary before one can employ them as distinctive characters. Still in the hands of an expert, whose experience has taught him the necessary precautions in this regard, they yield valuable hints in the absence of shoot-sheaths. The parts that can be distinguished on a leaf-sheath are the same as those of a shoot-sheath, *viz.*, the sheath itself, its mouth with its auricles or fringes, and the ligule; the imperfect blade is here developed into a perfect stalked leaf-blade.

The inflorescence of bamboo exhibits great variations. All species of bamboo remain leafed at the beginning of flowering,

and lose their leaves only gradually as the flowering progresses. Hence we can find all stages from simple cluster-spikes to compound immense radical panicles, according to the advance towards defloration. Sometimes defoliation takes place very late; in other cases only partially or not at all, as for example in the varieties of leleba and most of the species of *Schizostachyum*. In other cases certain halms of a bamboo-stock burst into flower, lose their leaves, and die off, while the rest of the halms continues flowerless. The male bamboo normally does so regularly in India, but in Burma, especially in the dry stony laterite tracts of Prome and the Irrawaddi valley, the whole stock takes to flowering and dies off. This is the more remarkable as the same species follows the normal rule of flowering on the dry sandstone hills of the Pegu Yomah. The *Arundinarias* for the greater part use to flower freely without dying off, but a few small species growing at high elevations die off to the ground and throw up new shoots the following spring. However, the general, if not universal, rule of flowering is that the whole stock becomes affected and all the halms simultaneously burst into flower, lose their leaves, and the stock dies off, sometimes already the first year (very rarely), but more usually gradually during 2 or 3 years. The flowering is during this period so profuss that spikelet after spikelet is produced, and a flower-cluster that at the beginning had only half an inch in diameter may measure as much as two inches at the fruiting time. Indeed the bamboo stock becomes exhausted through flowering, hence Malays, as other Indians, do not like the flowering of bamboo, and cut down the halms as soon as the first sign of flowering shews itself. The Bengalees and other Indians even believe that flowering of bamboo brings misfortune.

The age at which bamboo begins to set flowers is variously put down, and nothing quite conclusive is yet known about this point. But so much we can take for certain that flowering takes place at various ages according to the species itself, and also that the flowering period is not fixed within a couple of years only. Thus the age at which the more common kinds of Malaya and India flower (chiefly belonging to the section of *Ischurochloa* of *Bambusa* and *Dendrocalamus*) ranges between

25 to 35 years, and is almost regularly followed by the death of the whole stock, although a very few exceptional cases are known to me where a shoot was thrown up and grew and formed a new stock. In India, a man who has seen two kutungs (seedings of bamboo) is considered an old man, perhaps 60 years of age. Col. Beddome is of opinion that *Bambusa arundinacea* generally flowers at an age of about 32 years, he having ascertained the flowering of the same tracts in Western India in 1804, 1836, and 1868. However, the tall bamboos of the Indian Archipelago reach an age of nearly 100 years, *i. e.*, the whole stock, not the halms, which die off at a certain age. Remarkable is bamboo ul-ul of Bandong (*Schizostachyum elegantissimum*) which flowers and dies off every third year. This sort has also comparatively the thinnest wood of all bamboos known to me, although growing up to a height of 20 to 25 feet with the halms as thick as an arm.

In the plains, and generally in the drier tracts of continental India, where only few species of bamboo grow, and these in large quantities over whole tracts of land, the simultaneous flowering of bamboo is a conspicuous phenomenon to all, and hence such occurrences are numerously recorded in agricultural journals and even in the newspapers. Thus flowering of bamboo is recorded by Capt. Sleemann in Dehra Dhoon in 1836, when all bamboos died. Lieutenant J. F. Pogson reports that all the three sorts of bamboos flowered at Simla in 1858. These three kinds were a large hollow bamboo; the female bamboo, which is rarely more than $1\frac{1}{2}$ inch in diameter; and the solid or "male" bamboo, perhaps a trifle thicker than the preceding. Mr. J. D. Gash of Pertabgurh reports in 1869 the flowering of the kutwasee, one of the four sorts grown in Oude, *viz.*, kutwasee, chah, lore and phool-bassa, adding that bamboo also flowered at that locality some 25 years ago. Mr. Macalpine records flowering of a bamboo, called kulgai, in Chittagong in 1867. He mentions also the flowering there of tulla bansh (probably talda?) in 1865. Col. C. S. Ryder similarly reports simultaneous flowering of the bamboo around Jubbulpore in 1873. The berry-bearing bamboo in Arracan fruits every 30 to 35 years, and the process appears to occupy a couple of years. It flowered last

in 1864-65 over the whole of the Arracan Yomah. Numerous other, more or less reliable datas, are at my disposal of similar occurrences, but they do not tend to promote the solution of the question at issue, *viz.*, the settlement of the age at which a species of bamboo flowers, as they only state that some sort of bamboo has flowered.

On the other hand, the flowering of bamboo in more damp countries, as in Burmah, etc., is such a common-sort occurrence that it never attracts the curiosity of the inhabitants; but the Karens bring this flower-period into calculation in their toungya cultivation, for experience has taught them that the rats are attracted and multiplied in such quantities when bamboo sets fruit, that they had really at occasions to abandon their fields and to leave the produce to these voracious creatures.

But there are apparent exceptions even to those cases where simultaneous flowering is characteristic to a species, and thus bamboo hower, which after flowering dies off even in the damp Malayan countries, may be seen in Bengal flowering only on a few halms, while the stock and the remainder of the halms remain alive and vegetate vigorously. A few other such occurrences have come under my observation, and I think that these anomalies may be explained by knowing that weakening the growth by whatever means induces premature flowering. Thus we may also partially account for the dead halms that we meet in bamboo-forest, and to which I already alluded to above. Indeed it happens sometimes that we meet one or a few flowering halms even in the primeval forests under the very circumstances just described.

From my own observations, and they extend now over 20 years, I must concur with the general notion of natives that drought greatly encourages flowering, although a certain age, or say rather state of debility, seems requisite before this favourable influence can fully come into play. So for example I have observed in Burma pygmaean plants of tinwa (*Cephalostachyum pergracile*) of only about ½ to 1 foot height, which had been continuously burnt down by junglefires, and which flowered together with their unhurt companions of 30 to 40 feet height. But strugglers from seeds that germinated at a latter date (say

the subsequent year may also be seen occasionally amongst the patches of flowering bamboos without producing a single flower. In such cases we have to generalize upon the broad facts before us, and leave stray exceptions as interesting hints for the consideration of casual phenomena. Both dry seasons that I spent in Burma were described to me as extraordinary hot ones, such as the oldest people could not remember, and my harvest of flowering species of bamboo was remarkably large, so much so that I missed the flowers of few species only, and these were such kinds as grew in tropical forests or near water, and hence were not likely to be affected by drought. Never were so many *species of bamboo in flower in the Calcutta Botanical Gardens* as in 1874—a year of drought and famine. Flowering of bamboo during times of famine is very usual, and there is a saying with the Indian that "when bamboos produce sustenance, we must look to heaven for food." The correctness of this proverb has been challenged, but I believe upon very insufficient grounds, for although bamboo may, and does, flower and fruit in years where the most beautiful crops are harvested, it does not follow that there was no drought in that season. How important an event the general flowering is in time of famine may easily be gathered from a few facts. In 1812, in Orissa a general flowering of bamboo took place, and prevented a famine. Hundreds of people were on the watch day and night in order to collect the seeds as they fell from the branches. Mr. Shaw Stewart, the Collecter of Canara (Western coast of India) *states, that in 1864 a similar event took place in the Soopa* jungles, and that a very large number of persons, estimated at 50,000, came from the Dharwar and Belgaum districts to collect the seeds. Each party remained about 10 to 14 days, taking away enough for their own consumption during the monsoon months, as well as some for sale; and he adds that the flowering was a most providential benefit during the prevailing scarcity. Mr. Gray, writing from Maldah in 1866, says: "In the South District, throughout the whole tract of country, the bamboo (probably *bamboo tulda?*) has flowered, and the seed has been sold in the bazaar at 13 seers for the rupee, rice being 10 seers, the ryots having stored enough for their own

wants in addition. Hundreds of maunds have been sold in the English Bazaar at Maldah; and large quantities have been sent to Sultangunge and other places 25 to 30 miles distant, shewing how enormous the supply must have been. The bamboo flowering has been quite providential, as the ryots were on the point of starving."

Here we have at once a key in dealing with the mitigation of famines in India, and bamboo-reserves for famine years would no doubt be preferable to mahogany and other timber plantations under the shade (?) of which the Bengalee ryot could only study the effects of hunger. Such reserves are the more recommendable, as there are many wastes now uncultivated which might be used as such, and along the Ganges endless savannahs expand which might profitably give way to reserves of bamboo. But only few bamboos would be eligible for this purpose, and of these behoor bans (*Bamb. arundinacea*), dyowa bans (*Bamb. tulda*) and basini bans (*Bamb. vulgaris*) would be the preferable ones, the first one being adapted also for drier climates, like the Upper Provinces; the two latter ones are preferable for damper climates, as Lower Bengal, etc. There are other freely flowering bamboos, especially the so-called male bamboo, a kind which grows, unlike the above noted, also on sterile rocky hills, but the seeds of this kind, although larger, has a pretty large pericarp, and is by no means so productive as those kinds named above. Indeed, while here only 1 to 3 seeds to the spikelet are found, there are as many as 4 to 8, which latter do not require to have the pericarp first removed, as is the case in the male bamboo. Unfortunately we know nothing about the exact quantity of seeds which every stock yields, but we may presume that it must be enormous. We have, however, much to learn yet of the life-history of these bamboos before we can advantageously employ them for famine-purposes, and first of all we require to know the exact age at which flowering can take place. Besides, yearly after sowings are necessary so as to ensure regularity of crops, etc.* Such bamboo-reserves would at the same time

* Thus in order to obtain a single acre's yield after a lapse of 30 years, it requires 30 acres to be planted successively at the rate of one acre per year. Under such circumstances it is most important to know, whether the yield of one acre of bamboo-rice

contain also other food-plants, as for example aloo, diverse kinds (*Dioscorea sp.*) say about 3-4 plants to each stock; *Tacca pinnatifida*, ol (*Amorphophallus campanulatus*); varieties of kuchoo (*Colocasia antiquorum* and *C. Indica*); tapioca and cassava (*Janipha manihot*), and such like tuberous plants as do not interfere with the plantation, while their value would be enhanced, provided that the people would be prevented from using these products without a regulated control. Trees, like mango and jack, and in drier districts the muhooa (*Bassia latifolia*) and the carob-tree (*Ceratonia siliqua*), the latter on calcareous sub-soils, might be added or interspersed in the bamboo-grooves. Add to the above bamboo-reserves revised and strict rules regarding fisheries (for fish is an important article of food to a great class of natives); an attempt on the part of the forester to redeem the numerous courses of rivulets that are now dried up in the arid hills of the Peninsula, Behar, etc., by replanting their sources with trees and thus recreate their flow, and have these sources combined with a judicious extension of irrigation works, and I see not why famine could not be banished or at least so greatly diminished as to dwindle down to mere temporary scarcity.

Noteworthy is also the innate individuality of bamboo as shewn in its flowering. Cuttings or root-layers taken from the flowering stock (and even if taken before flowering) will burst into flower just as their parent-stock. Hence, natives use to cut down all the halms a year before flowering if possible, and thus prevent that the stock flowers itself to death. How they should, however, know, when their bamboo-stock goes to flower, can only be explained by assuming that some

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(which sells lower than common rice) is equal or inferior to the yield of any crop that could be raised on the same land (which of course must be such as would be declared *a priori* unfit for rice cultivation) during the same period of time.

The densest bamboo-growth to an acre is 440 clumps, or say 400 at an average. The yield of each clump may be set down as two maunds at a minimum. Thus an acre would give 800* maunds of bamboo-rice every thirtieth year from the sowing. This, however, makes only about 26⅔ maund per year calculated in the proportion to the whole area occupied (30 acres). To this must be added the entire loss of products (except minor ones derived from root-crops etc.) for the period of 30, and eventually upwards to 34 years! If planted on recognised ricelands, the loss (circ. 27,000 maunds of paddy) would be enormous under these circumstances, if we take an average fair crop of paddy at 30 maunds of paddy per acre annually.

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* I fear this estimate is far beyond the quantity which would actually be obtained.—*The Editor.*

premature partial flowering takes place as an indication of the subsequent total floration. When a bamboo-stock is once in flower, cutting of the halms does not check the flowering.

The inflorescence of a bamboo is virtually always a contracted panicle terminating the branchlets. Through gradual defoliation, however, originate the terminal or even the radical imposing panicles formed by the thorough flowering of the whole halm, which bears only more here and there a small bunch of leaves, the remnants of a past state. The spikelets formed of a distichous accumulation of florets, are sometimes crowded at the end of the branchlets, and separated by them by a few sheathed joints, in which case they form heads (as for example in *Schizostachyum chilianthum*,) very rarely do they singly spring from above the jointings, or casually in great irregularity between the flowering branchlets (as in *Schizo. Blumei*). In some *Arundinariæ*, however, they often appear singly and long-stalked.

A spikelet (see plate I., figs. 4-6) consists in a perfect state of two basal glumes, of which one or both may be reduced or abort altogether; then follow a number of distichously placed valves, or paleas, outer and inner, in which rest the true floret consisting of tender scales, stamens or ovary or both. A bamboo-spikelet can very well be looked upon as being a reduced inflorescence, for most species (except *Arundinariæ*) have buds in the lower paleas, which develope under certain circumstances into independent spikelets. So for example, I have figured on plate I., figs. 9 and 10, whorls of spikelets of bamboo andong and b. atter, some of the spikelets of which have assumed almost the aspect of new flowering branchlets through the elongation of the primary rachis, while the buds of the lower paleas are developed into independent spikelets, which, however, have themselves become gemmiparous in their lower paleas; but the true nature of the spikelets remains still demonstrable on account of the uppermost perfect florets of the spikelet which remain in their normal state, for they are not susceptible to further development, and therefore have undergone no other change except a slight enlargement likely due to the vigour of the would-be spikelet. This phenomenon is a very frequent one with

the above two species, while in *Schizostachyum* and a few other bamboos this wonderful successive and repeated development of buds into perfect spikelets has become normal in a slightly modified way. Here we never see the sterile pedicelli (stalks) between the spikelets at the beginning of the flowering, (see plate I., fig. 7) but they appear at a latter period (l. c. fig. 8), after the buds of the lower paleas become developed and by their pressure have dislodged the upper deflorate mother-spikelets, thus leaving behind only their pedicelli. This process of development of buds continues for a long time, for also the new developed spikelets form buds in their lower paleas, while the numerous undeveloped spikelets, of which such a fascicle of spikelet is composed, become in their turn similarly and repeatedly developed.

Such whorls or clusters of spikelets are always enveloped in a sheath, which often becomes quite reduced and scale-like, while in other species it becomes much developed and remains until the destruction of the whorl itself. It is similarly shaped to those of the branch-buds, but smaller and more tender, and similarly furnished with an imperfect blade, which however is only in *Phyllostachys* well developed and persistent, while in all other species it regularly falls off or is often entirely arrested in its development. The single spikelets, too, are furnished at the base with similar smaller sheathlets which now partake more the shape and consistence of bracts, now that of glumes; in *Phyllostachys* they are also often furnished with an imperfect blade. Most distinctly developed appear the glumes in the pedicelled spikelets of *Arundinariæ*, and in those bamboos where they become casually pedicelled, while in sessile spikelets (thus in most true bamboos) they are totally arrested in growth or only rudimentary.

The outer paleas are variously shaped according to whether they are taken from the lower empty or the upper perfect flowers, but they are very constant in their characters *inter se*, and only casually excurrent into an imperfect blade (*Phyllostachys*). They are concave or involute, of a coriaceous or papery consistence, keeled or not, slightly striated, nerved, or in a dried state, often channelled, fringed or nude on their margin, bluntish to long-subulate-pointed. The inner paleas are usually of a more tender

consistence, shorter or longer than the outer ones, depressed or flat on the back and double-keeled, with the keels and inner margins fringed or nude; but in *Schizostachyum* they are also terete with their margins more or less involute. For generic distinction, the inner palea of the hermaphrodite florets furnishes reliable characters.

The flowers of a bamboo-spikelet are always distichously arranged and usually manifestly so, rarely so to a less degree (caused by the overlapping of the outer paleas) in *Schizostachyum* and some other genera. The development of the flowers in a spikelet takes place successively from below upwards, so that the lowermost ones are long deflorate before the upper ones begin to develop themselves. This circumstance must partially also explain why it takes such a long period, before a bamboo-inflorescence becomes wholly deflorate. The uppermost floret is usually rudimentary and small, often pedicelled and somewhat exserted, but also as often reduced to an outer palea or to only a sterile pedicel. In some species of *Schizostachyum,* the uppermost floret not unfrequently becomes developed and perfect. In *Dinochloa*, *Beesha*, etc, is the uppermost floret always perfect and hermaphrodite, but in many other genera there is no definite rule, and the spikelets become now all unisexual, or only one or the other of the florets becomes hermaphrodite, or under certain favourable circumstances all florets become hermaphrodite, except the lowermost bud-bearing paleas. The development of hermaphrodite florets seems to stand in some connection with climatic influences or more probably with the exhaustion caused by wholesale flowering. Thus I found in the Botanic Gardens at Buitenzorg in 1862 only hermaphrodite florets on the stocks of bamboo andong (*Giganto-maxima)* then abundantly flowering, while in 1863, thus the following year, the unisexual florets appeared in the usual preponderance in all the spikelets of the same stocks I had examined the preceding year.

Until now we have observed in the arrangement of the vegetative parts an almost immutable distichismus: indeed from the very halm-shoot to the branch-shoot, the leaves, the glumes and paleas, we can perceive a regularity of repetition of the same

parts which at once point to their analogy in spite of their unequal development and modification. But in the true floret the arrangement of the parts becomes ternary or a multiple of three.

The lodicules, small scales surrounding the ovary outside the stamens, take the place of petals, and their normal number is 3, rarely fewer by abortion, or they are regularly absent. In *Beesha*, a very anomalous genus, their number is increased to 6-8. Their presence or absence is in most species constant, but in a few species of *Schizostachyum* they are present or absent in spikelets of the same inflorescence. If present, they are fringed or naked on their edges, entire or lobed, of a hyaline texture, but in the *Bamb. nana* they become sometimes quite fleshy and rounded at the base.

The number of stamens is mostly 6, usually placed in 2 whorls of 3 each, occasionally and abnormally it is increased to 7-8, or in a similar manner reduced to 5 or 3-4. In *Arundinariæ* they are normally 3 in number, but the late Mr. Wichura has found a Japanese species, of which the stamens regularly number 4, 2 of the inner series being suppressed. *Beesha* has as many as from 7 to 30 stamens! The filaments are either short and just peeping from the paleas, or very elongate and pendulous, free or in a few genera united into a tube. The anthers are 2-celled, but the cells are often longitudinally incurved, and for this reason appear spuriously 4-celled; the connective is subulate-produced or blunt. I find their colour tolerably constant in the various species I have been able to examine in a living state, and this varies from purple to sulphur and green, but sometimes also two-coloured. As is well known, the stamens of bamboos are protandrous, that means, the anthers are developed and shed their pollen before the stigma of the same floret is fit for receiving the pollen: hence fecundation of the ovules can take place only by the pollen from other florets and this is effected by winds.

The ovary, which occupies the centre of the floret, is linear-flask-shaped, oval to nearly pear-shaped and obovał, sessile or (*in Phyllostachys*) spuriously stalked. The style is nearly wanting, very short or very long and filiform, tender and caducous, or in the so-called berry-bearing bamboos stiff and

straight or fleshy, undivided or terminating into 2 or 3 plumose stigmas. These stigmas are remarkably constant in colour, either white or purple, or (in leleba and the male bamboo) white with purple hairs intermixed.

The ovary engrosses in two ways, forming either the normal bamboo-fruits (see plate II., fig 14-16), which resemble those of other grasses, as oat, wheat, etc., and possess a membranous pericarp only; or they grow out into "berry-like" fruits (see plate II., figs. 13 and 17 and 1-2) which were supposed by Colonel Munro to be surrounded by a perigynium like in the sedges (*Carex*). But this view, on a more careful examination, has turned out to be unfounded, for this supposed perigynium is virtually nothing else but the indurated outer wall of the ovary (pericarp), while the inner stratum of looser cells becomes detached from the outer wall and remains as a spongy mass round the true seed. The ripe fruits are very characteristic for the several genera, but unfortunately many of the species rarely fruit, and some are not yet known to have fruited at all. Their shape and structure varies greatly. Most of the species have small fruits only with a thin membranous covering, and are similarly shaped as in wheat, oat, etc. (see plate II., fig. 14, 15, 16). The largest bamboo known to me (*Giganto. aspera*) has also the smallest fruits! On the other hand, the fruits of most *Schizostachya* (see plate II., fig. 1-2) are rather large, the size of a lentil to that of a pea, and terminate in a stiff, longer or shorter beak. *Pseudostachyum compactum* (see plate II., fig. 13) has irregularly globose fruits, the size of a small wood-apple, which germinate already while still attached to the mother-plant. This has also the largest seed of all bamboos, the pericarp being thin and coriaceous. Still more interesting are the fleshy fruits of *Melocana baccifera*, which attain 4 inches by 3, and besides terminate into a fleshy beak about two inches long, so that the whole length amounts to 5 inches! Here the seed is comparatively small, while it is the fleshy pericarp which make the fruit so bulky. These also germinate while still growing on the plant, and Mr. W. L. F. Robinson of Rungpore thus describes the germination: "A good watch was kept on those fruits on the trees, and the result is this,—as they get

ripe, out of the big end, by which they hang from the tree, springs a young bamboo-leaf and also a bunch of roots; when the young shoot is some 6 inches long, the whole thing drops off the tree, and apparently plants itself in the ground by the roots. It seems a queer thing that the bamboo should reproduce itself on the tree without going to the earth first."

The bamboo-fruits, usually accompanied by the somewhat enlarged lodicules (if present), and both paleas, as well as the rudimentary florets, readily drop from the plant and germinate usually within the first week after they have fallen to the ground. They may, therefore, be reckoned amongst the quick-germinators. Nothing, however, is known as to the length of time that bamboo seed retains its vitality, although in the case of those species, which germinate already on the tree, we can safely assume that they are utterly perishable.

The vital activity of the seed commences on the fourth to the seventh day after they have been sown, and the subsequent development takes place pretty fast. On plate II. fig. 1-12, I have illustrated the germination of a seed of a so-called berry-bearing bamboo, *viz.*, that of booloo akkar (*Schizostachyum chilianthum*). Here the lower blunt end of the cotyledon (l. c. fig. 6) protrudes about the fourth day after sowing through the pericarp, and is followed the next day by its upper part (l. c. fig. 7). Already the following day the primary rootlet, which is hairy, forces its way downwards to a considerable length, while the upper part has enlarged and separated into two equally large lobes which are separated from the downwards growing part by a more or less distinct constriction. These two lobes enclose in their axil the plumule which is stiff, hairy and striped and quickly protrudes from between them, as can be seen in fig. 9 (3 days later). The subsequent stages of development of the young plants are represented in figs. 10-11, as observed on the eleventh and fifteenth day after sowing. At the latter stage the growth of the plantlet becomes considerably slower, and although still connected with the seed, the cotyledon was entirely absorbed already before the fifteenth day of sowing, and thus the young plant is left to itself for further nourishment from the soil alone. On the thirtieth day

after sowing, the halm-sheaths and a leaf are fully developed (see fig. 12), but instead of seeing the growth now accelerated, it becomes considerably slower, so much so, that after a lapse of a year the plants reached only 2-2½ feet in height. The same slow growth of the young plants prevails in behoor bans, [illegible] bans or male bamboo (*Dendro. strictus*), and dyowa [illegible] (*Bamb. Tulda*), which all attain only about 1-1½ feet height in the first year, and do not exceed 4 feet in the third. Other species apparently grow quicker, and so *Melocana baccifera*, of which the fruits drop from the plant after they have made shoots some 6 inches long; these shoots attained a height of 15 to 16 inches after only 10 days that they were planted out in the gronnd, but had thrown out only 2 leaves. However other and more reliable observations are required, before we can come to final conclusions as to the growth of bamboo in its first years after sowing. The time required for the full development of the larger kinds of bamboo in the Malayan Archipelago oscillates between 12 to 15 years, but Captain Sleeman estimates the time required for the full-growth of bamboo in Deyrah Doon at 8 to 10 years only.

The propagation of bamboo from a practical point of view can be effected in four ways, *viz.* :—

First, by seed, the slowest mode, but the easiest, and at the end the most advantageous.

Second, by cuttings. This mode is very commonly adopted by natives, and as easy as the propagation of willows. Any joint with a node on it, even if taken from the main-halms, will strike root, provided the necessary moisture is applied.

Third, by taking only the lower part of a halm with a piece of the rhizome, and treating it in the same way as the cuttings. This method is generally in use all over India and the Archipelago, and yields vigorous clumps in the shortest time possible.

Fourth, by taking whole halms with their roots and burying them lengthwise in the ground. By this process the alternating branch clusters send forth young branch-shoots which gradually become transformed into stronger and stronger halms in the proportion as roots are formed. Thus large areas can be planted with little trouble.

It is hardly necessary here to add that all these 4 modes of propagation have to be carried out with the setting in of, or during, the rainy season. Care should also be taken that the cuttings, etc., be not taken from flowering stocks, as they may be sure to flower like their parent-stock and die off, or certainly remain weak and make little progress in growth.

(*To be continued.*)

The following 3 papers were written for the late Forest Conference at Simla, and made over for publication to the Indian Forester.—THE EDITOR.

On the formation of lac preserves in the forests of the Central Provinces.

BY J. McKEE.

MUCH has lately been written about the Coccus Lacca and the resinous substance deposited by this insect known as Lac. Mr. O'Connor, Assistant Secretary, Department Revenue, Agriculture and Commerce, in a note published a short time since, gives a most interesting account of the important part played by this article in the commerce of the country, and the extent to which it is exported to Europe; he also appends a report by Dr. Carter, F. R. S., on the natural history of the insect, about which very incorrect ideas existed up to that time. This paper can add little new matter to the information already procurable on these points, and will rather confine itself to describing the method of propagation as practised in the Central Provinces and noting the chief points to be regarded in the formation of lac preserves.

It would appear from the table published in page 17 of Mr. O'Connor's report, that the average exports of shellac from Calcutta during the three years previous to 1874, equalled cwts. 63,381 or maunds 88,732, which, if valued at the moderate rate of Rs. 80* per maund, must have been worth Rs. 70,98,560, or nearly three-quarters of a million sterling; besides this, however,

* Present quotations are Rs. 86, and the price has risen as high as Rs. 100 per maund.

large quantities of sticklac must also have been shipped for transport to foreign countries.

We learn from the same report that in England and on the Continent shellac is extensively used in the manufacture of sealing wax, liquid varnish and the composition of certain inks, and is now in universal demand as a substance employed in the manufacture of hats. In this country, where large quantities of the article are also consumed, it is chiefly worked up into ornaments and varnishes, the red coloring matter, which is now only exported in small quantities, being used as a dye. The natives employ raw lac in making the bangles worn by the lower classes, while the best shellac is turned into similar ornaments of greater value, as also into beads and rings. Lac is employed too as a vincer on cabinets, toys and images, and is applied as a cement in the composition of the polishing grindstones used by lapidaries. The raw material is supplied from most parts of India, *viz.*, Assam, Bengal, and Burmah, but a very large proportion of the whole appears to be collected in the Central Provinces, the trade returns of which place give the following quantities under imports and exports for the past five years :—

Imports	1870-71	...	Maunds	8,505	Rs.	1,29,882
„	1871-72	...	„	4,578	„	71,510
„	1872-73	...	„	1,217	„	14,164
„	1873-74	...	„	3,328	„	54,473
„	1874-75	...	„	10,245	„	2,67,738
Exports	1870-71	...	„	16,423	„	2,17,957
„	1871-72	...	„	36,880	„	5,47,436
„	1872-73	...	„	25,581	„	6,45,457
„	1873-74	...	„	58,069	„	12,57,000
„	1874-75	...	„	82,521	„	26,22,915

From these figures it will be gathered that the exports have increased five fold in quantity and twelve times in value during the period for which they are given, *viz.*, between 1870-71 and 1874-75, and that the gross estimated value of the lac sent out of the Provinces now amounts to over 26 lacs of rupees, or Rs. 31 per maund.

The imports are mostly from the adjoining states of Rewah and Bhopal; but as the quantity that comes into the country

is supposed to be consumed partly in the Jubbulpore factory and partly in the local trade of Boorhanpur, where it is used in glazing pottery and the manufacture of native bracelets, the quantities quoted here as exports must be nearly all collected in the Provinces.

The increase in the trade of shell and stick lac has been so remarkably rapid, and the prices obtained in Europe for the manufactured article so large, that the attention of Government has lately been attracted to a scheme for developing the production of the raw material by introducing colonies of the insects into parts of the reserves under the Forest Department, and encouraging their propagation. At present nearly all the lac is collected by private individuals from the unreserved and private forests; in the former the right being sold annually to the highest bidder, while in the latter most of the large firms interested in its manufacture have obtained leases ranging in period from 8 to 10 years, a tenure which gives them the opportunity of increasing by cultivation the ordinary natural yield. It is well known that large sums of money, amounting latterly to about 15 lacs annually, are circulated throughout the Province in the collection and manufacture of this material, much of which as before stated is obtained from the Government forests, but strange to say, in spite of its being usually classed as one of the most valuable minor forest products, the state has never up to this time reaped any considerable gain by its sale, probably not more than Rs. 15,000 per annum; the reason given for so small a revenue being realized from this source is, that up to the present the leases of Government forests have never exceeded a year's duration, in which time it would not be possible for the purchaser to do more than gather the lac which had established itself in the natural course of events, a process, compared with that of artificial propagation, causing much delay and an excessive expenditure in the collection of a necessarily uncertain yield. By a late order of the Chief Commissioner, however, the periods of these leases have been extended to 8 years, a concession no doubt calculated to increase this item of revenue in the future. The reserved tracts under the immediate superintendence of the Forest Department pre-

sent so many facilities and appliances for the production of lac, which do not exist in the less-strictly protected private and unreserved forests, that in spite of their comparatively small areas they may be looked on as the future medium for supplying the greater portion of the demand. The private individual must keep up a large establishment to search for and collect this product over an indefinite extent of country, or should he propagate it artificially, a method resorted to at present in only a few places, a still larger staff will become necessary for the formation of the plantations and their protection, while many failures and disappointments must result from the destruction of the nurseries or deterioration in the value of their produce, caused by the almost annual occurrence of forest fires. In the reserves however extensive areas have been protected successfully from fire for years past, while the establishments which will eventually be necessary for their management will be nearly adequate to superintend the additional work, and be the means of lessening the cost of producing the article; and this may be further reduced by the fact that the State could at less expense fully stock the land with trees up to the point at which it would yield a maximum out-turn of lac per acre and could better afford to spare the time necessary for this result. In short, there is every probability that owing to the advantages possessed by the reserves lac may be produced by the Forest Department far cheaper and of better quality than it could be raised by other agencies, and that, should the demand for the article continue of sufficient magnitude to induce Government to produce it on a large scale, the time must come when it will be to the advantage of the manufacturer to purchase his supplies from our depôts.

If the above reasons appear sufficiently stable to justify the State in these expectations, then the only other points which seem necessary to be determined are first, whether the State can afford to put aside areas of forest land adequate for this special work without affecting the needful timber supply; and, secondly, whether it can reasonably hope to realize from it a fair pecuniary advantage. On the first point there can be no doubt as regards these Provinces, where the areas of the present

reserves could, if desirable, be extended without difficulty; and on the second, the figures at our command tend to demonstrate that the undertaking would be highly profitable. To prove this it will be essential, first, to shew the cost of preparing a given number of trees, or as I have termed them lac standards; secondly, to shew the yield that may be expected from them; and thirdly, the money value of the same.

With regard to the cost, this will necessarily vary with the description of the trees employed for the purpose, and the proportion they bear to one another in numbers on a given area. Such trees as Pallas (B. frondosa) and Ber (Z. jujuba), which are of comparatively small size, and which are found in many places in a state of almost pure forest, will necessarily cost less to bring under cultivation than larger species, such as Koosum (S. trijuga), Gooler (F. glomerata) and Peepul (F. religiosa), which are generally found either scattered about the forest or fringing the slopes of ravines and the banks of the rivers, for less brood lac will be required for their treatment and less trouble and time employed in searching for them; but on the other hand, the larger outturn obtained from the latter species will more than repay the extra money expended in preparing them. Our experiments extend at present to having operated on 7,467 trees of the Pallas and smaller species, and 1,903 trees of Koosum; these numbers represent the standards on which the insects are doing well and do not include a large percentage which turned out failures. The total cost of bringing the above under cultivation, including all charges, such as collecting brood lac, attaching it to the trees, &c., averages Rs. 3-5-11 per 100 trees of Pallas and Rs. 15 per 100 trees of Koosum. Owing to the dryness of our summer and the great damage to the lac caused by the hot winds, it does not seem probable that we can look forward to even two good crops in the year; the summer one will probably in almost all places, except those very favourably situated, be of poor quality and the quantity of lac developed not more than sufficient to leave on the trees for producing the crop which matures during the cold season. This lattter will generally be good and must be the one we depend on for a return. Reckoning then on only one crop a year, and

estimating the yield per tree at the moderate quantities of 3 seers for Pallas and 15 seers for Koosum or trees of like size, we obtain a net outturn, after deducting 25 per cent. for wastage in drying and packing, from the Pallas and small trees of maunds 5·25 per 100 trees, and from the larger species of maunds 27·32, which, if valued at Rs. 15 and 20 per maund respectively will be worth Rs. 84-6 for the former, and Rs. 541 for the latter. Take from these sums the cost of producing the article, which in future will be, if any thing, less than heretofore, owing to the lac being obtained in one spot, and the net profit on 100 trees of Pallas will equal Rs. 81 and on the *same number of Koosum Rs. 526. Large areas of forest* are now available on which the number of Pallas and other suitable trees per acre quite equal or even excel the above unit, and the expediency of forming plantations of Koosum which area for area would yield a more valuable crop is under consideration.

Now with regard to the cultivation of the product. In forming preserves for the production of lac the first point to be considered is the species which it will be desirable to utilize as nurseries; the most favourable will be first, those which are found in largest numbers on a given area, always provided they are suitable for the purpose; secondly, that species from which the finest lac is obtained.

In the Central Provinces, lac is generally found on the following:—

Schleichera trijuga	...	...	Koosum.
Butea frondosa	...	...	Pallas.
Zizyphus jujuba	...	...	Bér.
Zizyphus xylopyrus	...	...	Ghontee.
Ficus religiosa	...	...	Peepul.
Ficus indica	...	...	Barghat.
Ficus glomerata	...	...	Gooler.
Ficus venosa	...	...	Pakhar.

But experiments have proved that it will also form on—

Tectona grandis	...	...	Sagon.
Acacia catechu	...	...	Khair.
Pterocarpus marsupium	...	...	Bija.

Terminalia tomentosa	... ...	Saj.
Dalbergia parinculata	... ...	Dhobeyne.
Lagerstrœmia parviflora	... ...	Lendya.
Ougeinia dalbergioides	... ...	Tinsa.
Kydia calycina	... ...	Barranga.
Eriolœna Hookeriana	... ...	Buti.

Of the above trees the light golden resin obtained from the Koosum is the finest, as from it the most valuable orange shell lac is manufactured, and next in quality is that obtained from the Pallas, which yields the garnet lac of commerce; wherever possible therefore the Koosum tree should be chosen for standards; but as the Pallas is generally found in much greater numbers, area for area, its produce will nearly compensate in quantity for the reduction in its value. Having selected the forest for experiment, the next point to fix on is the local date on which the insects leave the parent cells, a step of great importance, and one on which the first success of the plantation will very greatly depend; as, should the work of gathering brood lac be delayed until visual proof of the exit of larvæ is obtained, a vast quantity will be killed in the operations of collection, transport, and of tying the encrusted twigs on the standards selected for nurseries. The date of evolution having been fixed on with some certainty, twigs of that season's lac should be gathered about 15 days before, wrapped up in a few straws of grass and attached to the trees selected for production, with threads of Pallas root fibre or something else as easily obtained; each twig should be from 9″ to 1′ in length, and be attached to the upper and middle branches of the tree. The grass tied round the twigs acts as a means of communication from the lac to the branches and leaf petioles, by which many insects are saved that would otherwise die from want of nourishment; as owing to the crookedness and irregularities of the encrustations contact between them and the branches is seldom complete. It is also of importance to tie the brood lac to the upper and middle branches, as many of the lower ones, by this arrangement, become covered with insects, which are shaken or fall from above; whereas, if the lac be attached to the lower portion of the tree, many larvæ must fall to the ground and be lost. When

attaching the twigs it appears necessary to take care that the wood of the standard is not of denser composition than the wood of the tree from which the brood lac is gathered, as it is believed that the larvæ reared on soft wooded trees are comparatively weaker than those which are found on species of harder texture. There is an idea prevalent among the Gonds that nursery standards must be prepared with brood lac taken from the same species as themselves; but this has been proved to be incorrect. The brood lac yielded by the koosum, a very hard wooded tree, appears best suited for propagating purposes, as it succeeds on trees of all other species. When several trees of the selected species grow together, it does not appear necessary at first to artificially cultivate more than three-fourths of them, as during the succeeding evolution the remaining fourth will almost certainly be brought under preparation by natural means,* but as the success of the crop depends principally on the supply of juices obtained by the female insects during the period they continue to deposit the resin, it is necessary to place the brood lac on the youngest and most sappy branches.

Lac preserves may be formed by carrying out the above simple operations; but it is not probable that success will be attained at once or until experience has drawn attention to several peculiarities in the habits of the insect and the manner in which it is influenced by situation and atmospheric conditions. Our first attempts were made in the cold weather of 1874, but owing to the want of knowledge that prevailed on several essential points, both among the superintending staff and the laborers employed on the work, the extent of these were naturally limited and of small result. It was not known with any certainty when the exit of young larvæ commenced, or what was the best method of applying them to the trees; thus a large number were lost, and this destruction of insect life was greatly increased by the rough handling they were exposed to by the workmen.

* In 1874 1,300 trees were prepared at Kosai in the Satpura Reserve, in 429 of which the lac was destroyed during the hot weather of 1875, leaving 871, from the encrustations of which a new brood of larvæ swarmed in July 1875. The lac on those trees was not touched, owing to its being a bad crop, but was left for further propagating purposes. On the 19th August however, an enumeration of the trees on this spot proved that new lac was then being formed on 1,380 trees; thus 509 trees must have been affected by their proximity to the old standards.

In one instance a plantation which had been prepared and was progressing well was nearly destroyed by mistaking an evolution of male insects for one of larvæ,—an error into which it would be impossible to fall except through want of knowledge of the insect's habits; in another, the colonies were greatly damaged by a fire which broke out and destroyed the lac—on all but the highest trees; while in a third frost and hot winds killed the females and stopped the formation of lac on nearly half the number of trees prepared. But although we had to contend with so many mishaps, partly through ignorance and partly from physical causes, each experience in its way taught valuable information which will render more certain our future undertakings.

Of the points to be noted in making these preserves the one of greatest importance perhaps is the fact that the lac encrustations may be plucked several days before the larvæ appear,—a knowledge of which will enable a larger number of trees to be prepared during one working season than if it was necessary to delay the operations until the evolution actually took place, as owing to this latter being nearly simultaneous in and about one locality, the period for forming the plantations would be necessarily limited to the number of days it took for the cells to become empty, besides which, by attaching the lac twigs before the birth of the larvæ great numbers are saved, which would otherwise perish during the process of being attached to the trees. In support of this fact it will be interesting to give the following observations: Mr. Thompson, Deputy Conservator, in order to fix on a safe date for gathering the brood lac, caused twigs, covered with the encrustations, to be brought in from the surrounding forest every two days for examination, there be labelled, dated and hung up in the verandah of his forest bungalow; the first twig was gathered on the 10th June, and the others on every succeeding alternate day until the 12th July. These twigs were the produce of several trees, and were brought from various parts of the forest within a radius of 10 miles; some were plucked from the Gooler, others from the Peepul, but the majority from the Pallas. On the morning of the 13th July, according to custom, Mr. Thompson examined

the twigs, but found no sign that the larvæ had vacated their cells, although microscopic observations had proved them to be fully developed. On the 14th however an inspection showed that, on all the twigs without exception, the young were pouring out of the cells through the anal apertures; thus the twig gathered on the 10th June hatched exactly on the same date as the one gathered on the 12th July, or more than a month later. The same fact was accidentally discovered on quite a different plantation in the following manner: A large basket of stick lac collected from the koosum tree was brought to the forest bungalow on the 7th June, being then 2 days old, and put aside in a store room as being unripe and unfit for use. On the 28th of the same month however, on being casually examined, this lac was found covered with young larvæ which must have made their appearance about 24 hours before: in this case the stick lac had been plucked from the trees and thrown aside for 23 days and turned out useful for propagation after all. These two facts prove that the encrustations may be gathered from two to three weeks before the exit of the young, by which, as before explained, much better results will be obtained than if it was necessary to delay the work until this event took place. The date of exit varies considerably in forests separated one from another by comparatively short distances. For instance, the brood hatched last season is reported to have made its first appearance at Korai on the Satpuras on the 28th June, in the forests of the Western Division situated on the same range of hills, but about 50 miles to the south of the first named place, during the first week of August, at Mohurli, in the Chanda District, about two degrees of lat. further south, on the 14th July and at Ahei still further south in the same District, a few days earlier. These dates do not point to a difference in the lat. of forests being the origin of the variation noticed, and it is more probable that in these Provinces, which are situated in the centre of the insect habitat the disagreement in the dates of birth are caused by certain local conditions. The above dates refer to the summer evolution; the winter one issues from the end of October to nearly as late as the middle of December, but the exact dates of this last in the different plantations have

not yet been definitely fixed. While on this subject it is necessary to draw attention to the reported variation in the number of evolutions and consequently in the number of crops which are obtained in different countries. In Mysore and Burmah it would appear that three evolutions of the insect take place during the year. At para. No. 21 of Mr. O Connor's report he states that in the former place "the insects are applied to the trees three times in the year, the old branches with the insects on them being lopped off, made into small bundles and tied up to fresh branches," and in an addendum to his note it is stated by a late Burmah Forest Officer that "every four months or thrice a year the lac is collected, and thrice is the lac with the ova put on." As in the Central Provinces only one good crop a year can be hoped for at present, it would be interesting if the Forest Departments in Burmah and Mysore would give some details of the method employed in cultivating the insect in those countries, as possibly by attention and careful treatment the crops might be increased in these Provinces, a matter of much importance, as thereby a larger revenue would be realized, or the same quantity of lac obtained from a smaller area.

After the larvæ appear, they crawl about the stems of the plant in search of young juicy spots, from which, when once fixed by their probosces, they cannot be removed without fatal injury. The male and female are identical in size and shape, and both commence at once the formation of their cocoons by excreting a substance resembling lac, those of the male being void or elliptic in form, while those of the females are more circular and exhibit three distinct apertures arranged in triangular fashion in their roofs, (one being the anal aperture through which impregnation is accomplished, and the larvæ eventually swarm); the other two, those by means of which the insect obtains a supply of air. About 10 weeks after birth an important change has taken place in the larvæ, the female cocoons are completed, and the insects have assumed the final or imago state; but as the female never shifts her place but remains fixed in the position she first of all took up on the twig, the male is obliged to seek her, which he does by leaving his cell in a backward manner to the ventral aperture and crawling on

to the female cells, where he fulfils his office and almost immediately after dies. This exit of male insects is a fact well to know, as owing to the smallness of the animal and to the naked-eye his similarity to the original larvæ form, it is possible for a novice to mistake such an evolution for one of young larvæ and to commence gathering the twigs under the impression that a new birth of these latter had taken place. In fact, as above mentioned, such a mistake actually happened in one of our experimental plantations, causing its almost entire destruction; for it is obvious that if the lac is plucked before or immediately after impregnation has been accomplished, the females must perish from being cut off from their sap supplies, and as a natural consequence the young brood must be destroyed with them. This mistake however may easily be avoided, for the lac at this period is so little developed compared with its after growth that no one at all acquainted with its final appearance could imagine it to be fully formed at the date when the male evolution takes place; besides which, the filamentous processes which give to the lac the downy appearance so familiar to it, only increases rapidly after this period. Impregnation having been accomplished the female busies herself in sucking up large quantities of vegetable juices, increases greatly in size and begins the excretion of the true lac.

The females must be attached to young twigs by which bountiful supplies of fluid will be supplied them, otherwise they will die or never become fully developed, the lac cells will be small in consequence, and the eggs badly effected both with regard to number and condition.

This no doubt is the reason why in districts where the seasons are dry and where showers are of unfrequent occurrence during the hot weather, the summer crop is invariably poor and scarcely worth collecting. Moisture is one of the great essentials for a fine crop of lac, and many disappointments, if not total failure, will result by fixing on dry arid spots for the formation of plantations. The females cannot obtain sufficient nourishment at this period from the sapless stems, and their death will be recognized by the pitted appearance assumed by the cells, the crowns of which fall in as the insect contracts within them,

and by the cessation of the growth or disappearance of the white filaments which obtrude from the spiracular orifices. Species, such as koosum and gooler, which most frequently are found growing along the banks of rivers, where the atmosphere is humid and moist, are, for these reasons, especially adapted for yielding good crops of lac; while the pallas offers advantages, as its sap-producing functions are actively employed during the hottest season of the year when it forms both new wood and leaves.

Besides the damage brought about by fires, drought and frost, which to some extent can be guarded against, there are other enemies to the crop which are still more difficult to contend with. Mr. Thompson writes: "The ant both large and small attends the female cells for the purpose of licking up the sweet excrement: they do not appear to hurt the insect beyond biting off the ends of the white filaments, and thus bringing many an occupant of the cells to a premature end by cutting off the supplies of breathing air which the filaments serve to convey through the holes in the lac. Where ants are seen about the lac it never appears healthy, and many cells are found with the insect dead inside them. The lac whilst on the tree is also attacked by the larva of a moth, which appears to be a species of Galleria belonging to the ninth section of the Nocturnæ named Tineites by Latreille, one of which is famous for eating into the honey comb of bees, living on their larvæ and destroying their wax. Our insect eats the juicy females of the coccus and bores through the lac cells; it is found both in the field and the store room. A second species was also detected, which appears to belong to the genus Tinea." The ravages of these insects destroy the coloring matter contained in the females, and also all hope of a brood of young from the cells visited by them. At present there seems to be no way of protecting the lac from their depredations. The ants however may be circumvented, in two ways, either by surrounding the trees with wood ashes, or something sufficiently attractive to draw their attention away from the encrustations.

It seems possible, owing to the great drain made on the sap of the young branches by the insects, that considerable damage

will be found to result to the trees on which they are propagated, and that it will be necessary at some future time to fix a limit to the continuous cultivation of lac on the same tree; at any rate it will probably be found beneficial to both lac and tree, if a regular system of pruning be carried out to encourage the new formation of young twig or branch wood, and on the best methods of doing this, and on all other points in connection with the management of lac preserves we greatly hope that officers of the Department, who may have gained experience in this work in other countries, will convey all information available through the medium of our new forest periodical.

Kath or Catechu Manufacture.

BY J. MACRAE,

Deputy Conservator, Guzerat.

Kath-Catechu is extracted from the heart wood of the kheir tree, *Acacia catechu.* People employed in its manufacture are called Kathodias, an aboriginal tribe much resembling Bheels, with whom they occasionally, but not often, intermarry.

The men bring in the kheir wood from the jungle and cut it into chips; the women boil the chips and extract the kath.

The tree best suited for the purpose is one of about from 25 to 30 years of age, and the more distinctly thin white lines are perceptible in the heart wood the greater the quantity of kath it contains. The Kathodia tests whether the tree will pay to cut down by cutting a small notch into the heart wood.

After the tree is cut the Kathodia removes all the sap wood and a little of the heart wood with it, from the bole, and takes it home to cut into chips, which he does with a small axe of a peculiar shape; the log is held in a slanting direction on forked stakes buried firmly in the ground.

The end of the log rests on a piece of hard wood let into the ground, and the Kathodia keeps shaving it round and round to a point.

The chips are about the thickness of wood used for match boxes and about a square inch in surface.

The chips are boiled in small earthen pots, with rather more than two quarts of water; the chips are renewed three or four times a day, three or four handsful being put in each time. The water is poured off from time to time when considered sufficiently impregnated with kath into two pots kept on purpose, and allowed to go on boiling; fresh water is put into the pots from which the liquid has been poured off.

At the end of the day the infusion in the two pots is poured into a wooden trough, about a yard long and eighteen inches broad, and goes through a peculiar process of straining. A woman takes a piece of blanket about a foot square, dips it into the infusion, stirs it about and then rings it out again into the trough, holding it as high up as she can from a sitting position. This process goes on for about two hours, after which the trough is covered up with a cover made of split bamboos, and the infusion allowed to throw down a sediment, which is kath; all the water is poured off and the kath is made into small pats and allowed to dry.

Kath, ready made, is sometimes found in the centre of some trees. This kind of kath is the most valuable, and is called khyrsal.

The Kathodias are employed in large gangs from 50 to 75 families (each family represents a kath furnace) by contractors who obtain permits from the Forest Department for the manufacture of kath, and make their encampment near a river or large nulla in the jungle so as to have a large supply of water at hand; a kath furnace has from eight to twelve pots placed in a double row. The two centre ones are used to pour the liquid into from the other pots.

The contractor buys the kath from the Kathodias at 12 or 16 pots for a double pice equal to six pies, about 4lbs for the rupee.

Kath-manufacture is very destructive, and should never be permitted in jungles where the kheir grows straight or is accessible. If allowed, only such trees should be marked as are not fit for timber, by reason of their crookedness or other defect.

In the Bombay Forests, where manufacture of kath is allowed, none but crooked trees unfitted for timber uses are felled, and every tree is previously marked for the axe by the Forest Department.

Forest Terminology with reference only to the more important terms.

By A. Smythies, B.A.

In accordance with a suggestion of Dr. Brandis, the remarks in the following paper will be confined to terms that relate to forest treatment, to different classes of forest, and to different classes of trees. Among these I have only taken what appear to me to be the most important, and I do not pretend for an instant that the list is an exhaustive one. A mere string of terms, without either an explanation of their meaning, or the reasons that prompted their suggestion, would not be of much use, so I have, in most cases, given what I trust will prove sufficient to shew in what sense the proposed terms have been employed.

Terms relating to Forest Treatment.

The first term that presents itself under this head is that of *working-plan;* other terms have been proposed in its place, one of them is *management-scheme,* and if any change were made, either this term, or still better *working-scheme,* might be employed. As far as I have been able to ascertain, two objections have been brought against the phrase working-plan, neither of which are very serious. The first is that people often mistake it for a plan or map, and talk of a working-plan on such a scale, two or four inches to the mile. No forester, however, would be likely to interpret the meaning thus, and if every member of the Forest Department understands what is meant by the term, our chief object will have been attained; and, secondly, when it has been finally recognised as a technical term and promulgated as such, then I do not think the term will be misunderstood even outside the Forest Department.

The other objection is, that the working-plan forms only a part of the whole scheme, or in the language of French Foresters, the "plan d'exploitation" forms but a small portion of the "projet d'aménagement;" here the plan d'exploitation would be a tabular statement, shewing the number of years in the rotation, the composition of the various blocks, the areas of the compartments forming those blocks, &c., in fact it shews, in

a brief form, that certain portions of the forest will be worked during certain epochs of a long rotation. It does not seem to me worth while to reserve the term working-plan, because at some future time we may want to apply it to a similar purpose. It is a term which is in daily use amongst us, which you see in almost every official report, and the meaning of which we at least all understand, and I think it would be a pity to change it; but if a change should be thought necessary, then use the term working-scheme in preference to management-scheme.

We have several other terms immediately connected with the working-plan. The first three or four are generally understood and employed. They are, 1st, *working-circle*, the area over which each working-plan extends its operations, or in case of several working-circles for one forest, the area to which each special part of the working-plan applies (for the general part might embrace the whole forest); 2nd, *block*, any convenient sub-division of the working-circle; and, 3rd, *compartment*, a still smaller sub-division, varying in size, but containing as nearly as may be a homogeneous crop or one that may become so within a reasonably short space of time; we then come to *rotation;* in the treatment of a regular High Forest, this would signify the number of years devoted to the gradual and successive regeneration of an entire working-circle, and in coppice treatment it would denote the length of the intervals at which the coppice was cut. This strict meaning of the term rotation it is most important to maintain; in which case we must absolutely refuse to recognise its application in any other sense, such as the opening of certain portions of forest to the public for a time, and then closing them for a while, the total number of years thus occupied forming what has hitherto been called a rotation.

The *period* is some aliquot part of the *rotation*, and in regular High Forest treatment, there are as many *blocks* in the working-circle as there are periods in the rotation, and in each successive period, one corresponding block is taken in hand and regenerated.

The last part of this sentence introduces a term connected with that portion of the subject upon which we are at present

engaged. We have various methods of working High Forest, and we require as many terms to represent these methods.

The natural method I would propose to call the method of *natural regeneration by seed;* I use the term regeneration as opposed to, and in preference to, *reproduction;* we use the term reproduction as a phenomenon by itself in a passive or inactive sense; I propose regeneration instead as denoting agency, the active intervention of the forester, who by a series of cuttings brings a new generation of trees on to the ground; he does not reproduce the forest; sometimes indeed his wish is to do almost anything but that; but he does desire to regenerate the forest, in the sense of bringing a new generation upon the ground; this seems to me a most legitimate destinction between the two.

In the method of natural regeneration by seed, there are two distinct kinds of cuttings. The first kind I would term *regeneration* cuttings; the second *improvement* cuttings.

Various names have been given to the three *regeneration* cuttings; collectively they have been called *serial* cuttings, which, in my opinion, is not so expressive a term as the one I have proposed, as it does not give the slightest clue to their object; the term *regeneration* cuttings *does;* individually, they have received various denominations, such as preparatory, light, definitive, clear, seed, seeding, &c. None of these are good, and some of them are positively wrong. The best terms that have hitherto been proposed are *primary* cutting, *secondary* cutting, and *final* cutting; defining the primary cutting as the one which is to effect the germination of the seed or, rather to establish on the ground of the coupe, the necessary conditions for germination to take place. This has been called the secondary cutting, but this is a term that we should reserve for that cutting or cuttings (as they are often more than one) which gradually admit the young plants to the beneficent influence of light, rain, dew, &c., reserving the term final cutting for the last one of all, when, as a rule, the remaining reserves are felled, and the crop of young seedlings is left to take care of itself. Thus we have the complete series of regeneration cuttings, *primary*, *secondary* and *final*.

The *improvement* cuttings may well be called *cleanings* and *thinnings ; cleaning*, when the object is to get rid of obnoxious species that overtop and threaten the existence of more valuable trees; *thinning*, when dead and dying trees are removed, or those which are suppressed and will soon fade away and perish. The operation here termed a cleaning has also been called *weeding* and *clearing;* neither of these are admissible; weeding in itself is not bad, as it shews that the inferior species are removed by the operation, but we require the term weeding, for operations commonly known by that name, whether in the nursery, in plantations, or in the forest. *Clearing* must be restricted to the sense of clear cutting, or clear felling.

Thinnings may vary in the quantity of produce cut out, and consequently we must distinguish between *light* thinnings, *moderate* thinnings, and *heavy* or *severe* thinnings; to *thin heavily* or *severely* is a well-known ordinary expression, and the best term to use in opposition to this is to *thin lightly;* when we perform an operation that in intensity comes between the two, we may say that we *thin moderately*. The other terms applied to thinnings that have come under my notice are ordinary, extraordinary, mean, average and slight, which are neither so definite nor so useful as the terms I have already mentioned.

Another method of working High Forest is what may be called the *selection system*, or to be in harmony with the one first mentioned, the *selection method*. This has been variously denominated selection felling, and cutting by selection; there is no doubt that you do fell or cut by selection, when treating forest on this method, but that is no name for the method itself. This is no place to enter into the merits or demerits of this or of any other system of treating forests, as what we are now concerned with is to arrive at some good definite terms to express different forest ideas, but there is no doubt whatever that this plan of cutting trees by selection is a well recognised, thoroughly understood system, that frequently has its "raison d' être," and in consequence we need not be afraid of giving it too much importance by adding the word method or *system* after the word selection.

With regard to felling operations, we must make a distinction between *felling* and *cutting;* the term *felling* I would restrict to the actual cutting down of the tree—of the individual, and not of the whole community of trees; thus in coppice, the way you arrange your *cutting* does not very much matter, but the manner of cutting has a most important influence on the well-being and future development of the coppice. Here the idea is the individual cutting down of the trees, and the way in which it is done.

The term *cutting* is sufficiently explained by what has already been said on the method of natural regeneration by seed. But here again I would institute a distinction between the operation of *cutting* and the area or ground over which the cutting takes place; the French word for both is *coupe;* they talk, for instance, of numerous seedlings being found in such and such a "*coupe*" where the word coupe refers to a certain portion of the forest, and at the same time they talk of "coupes de regeneration, &c.;" for the word coupe, as used in this sense, we have employed *cutting;* for the former sense we might retain the word *coupe*, and we should then be enabled to use such phrases as, "the year after the cutting took place, the coupe or the surface of the coupe was thickly studded with fine young seedlings;" or again, "the coupe exploited in 1875, is now covered by a dense growth of shrubs and grass." The French definition of the word *coupe* is a certain portion of forest destined to be cut as a whole or in part; it seems to me advisable to have two words, one to denote the area or portion of forest, another to denote the operation. Thus of the operation we could say an *open* or a *close cutting* had been made, according as many or few trees had been removed, while the result on the ground we might denote as a *light* or a *dark coupe;* as a further illustration we might say that a certain species required an open cutting, as its young plants would not prosper in or under a dark coupe.

The Different kinds of Forest.

The term *High Forest* is well known to all of us; its main object is to produce large-sized timber, and it is, as a rule, regenerated or reproduced by seed. It does not seem necessary

to call it High Timber Forest; the word timber here is *de trop*, as the definition of High Forest shews that the production of timber is implied. No other term has been proposed as far as I am aware for this kind of Forest, nor need we seek for a better one. High Forest may be *regular* or *irregular;* the former where the different age classes are well distributed over the forest, where the crop is complete, and where all the necessary elements for natural reproduction of the good species are to be found; the latter where the age classes are confusedly mixed. The selection system invariably results in an irregular High Forest; the natural method in a regular one.

A *coppice* is a forest that is reproduced chiefly by means of shoots and suckers. We may have *simple coppice* where no *reserved* trees are left standing after the exploitation, or perhaps only a few left here and there as seed bearers; and *coppice with standards* where reserved trees, technically called standards, are left for one or more rotations of the underwood.

The latter has been called compound, composite, and mixed coppice; the term *mixed coppice* would refer rather to a forest where several species were growing together and is in opposition to *pure coppice*, which would consist of only one species; thus to take a few examples, an osier-bed is a *pure* coppice, and it is a *simple* coppice at the same time. A forest of this kind that contained nothing but teak, would be a *pure* coppice, and it would be *simple* or *with standards* according as no reserves were left or otherwise. If we had teak, dendia, saj, &c., growing together and no reserves were left, it would be a *simple* coppice, but it would not be a *pure* one; we should have to call it mixed. The term coppice under standards is almost identical with the one I have already mentioned, but I should prefer myself to see the preposition *with* used in preference to *under;* the latter might suggest the idea that the coppice grew up underneath the standards, which is not only not always the case, but is generally the exception. The former, *with*, shews that you have two distinct elements, the *coppice*, and the *standards*, and they are in fact, always looked upon as two separate items. There does not appear to me the slightest necessity for calling them *coppice Forests;* the simpler we make our terminology the better; but

on the other hand, it is a mistake to suppose that forest "is too grand a term to apply to mere coppice." In the eye of the law, and in practice, in every-day use, a coppice is a forest just as much as High Forest, and you would, in a general way, make use of the term forest without stopping to inquire whether it was worked on the Coppice or High Forest treatment. The term *composite* may be passed over in silence, but *compound* deserves a short notice. As in contradistinction to *simple*, there is no doubt that *compound* is a good term, quite as good as *with standards;* but the latter deserves pre-eminence, as it elucidates the nature of the forest a little bit more, and the more intelligible our terms are in themselves the better.

The word *copse* should only be used as a verb, and not in the sense of coppice.

Under the head of Forest treatment a few other terms remain to be noticed. There is the verb to *exploit* and its derivatives, *exploitable, exploitation,* and *exploitability;* in regard to these I have nothing further to add to the remarks made last year by Mr. Pengelly; I would keep all four as being more convenient than other terms, which would of a necessity be more cumbersome. With regard to an allied word "possibility," which has its own meaning, I would suggest the term *capability*, to denote the quantity of material that can annually be extracted from a forest, *on condition of taking out the same* quantity year after year without exhausting the supply—without trenching on capital—what the forest on this condition is *capable* of yielding. The annual yield of the forest is not necessarily the same, though I suppose that is what is meant by *normal annual yield.* The term *capability* is slightly more intelligible than *possibility*, and either of them is more convenient than, if not so expressive as, *normal annual yield.**

DIFFERENT KINDS OF TREES.

We have two grand divisions of forest trees, and it is essential to have some uniform term to express the distinction. The best term that I have yet seen for the one class is

* Mr. Smythies evidently misunderstands the meaning of the term "*normal annual yield*," which is by no means identical with his "*capability*," but which means the quantity of material, that a forest would be capable of yielding, if it was *regular* in every respect.—THE EDITOR.

that suggested by Mr. Pengelly, *viz.*, *broad-leaved species;* it will strike most of us as more appropriate than *leaf-bearing* trees, the only other term that I have met with in print—and it seems an especially good term for India where the leaves of many species of this class attain a considerable size. The other great division may be called *coniferous species*, or more shortly *conifers.*

Then with regard to the origin of forest trees, we may term *clump of shoots* the collection of shoots that spring up on the stool, after a tree has been cut down, *seedling*, the tree that proceeds from the direct germination of the seed, no matter what be its age, and we may call *seedling shoot* the tree that results from the cutting or burning down of a young seedling; most of the trees in tracts, regularly burnt by jungle fires, have originated thus.

When a forest is treated on the system of coppice with standards, we want terms to express the differences in age between the various standards; those reserved trees that are of the same age as the coppice may be called *1st class standards*, because they have passed through *one* rotation of the underwood; similarly, those of *two* rotations, *2nd class standards*, and so on. This will leave the expressions 1st, 2nd, 3rd, and 4th class *reserves* free for use, if necessary, in classifying the stock of a High Forest.

Terms relating to density of Forest.

We want a term to express a continuous state of dense growth of cover overhead—an equivalent for the technical French word "Massif." Mr. Pengelly has suggested the word "canopy," which is certainly better than the other terms I have met with, such as "close forest," "dense growth," "compact forest," &c. I would, however, slightly modify it and use "*leaf-canopy* instead, defining it as that state of forest in which the crowns of the trees touch each other without being swayed about by the wind. We may qualify the expression by the adjectives *dense*, referring to an exceedingly compact growth, and *broken* or *interrupted*, when the "leaf-canopy" has been very slightly opened out as after a close primary cutting; but if

much is cut out, the state of leaf-canopy ceases to exist, and we must employ such phrases as *opened out crop, open crop, open growth.*

It is obvious that we may have the state of *leaf-canopy* at all stages of growth, whether in the young seedling crop or in the mature forest, though the term would not be of much practical importance until after the final cutting.

At the same time we require different terms to express these various stages of growth. Taking the young seedling crop, we may say that it is in *the state of thicket* or *forms a thicket* when the trees still retain their branches down to the base.

The lower branches then begin to fall, and from this point until the trees have reached a certain size, either in diameter or in height, the crop may be said to be in the state of *saplings.* Whatever limit be taken for the sapling stage will denote the commencement of the next phase of growth, which may be termed *low poles,* or *small poles.* The succeeding stage may be denoted by the term *high poles;* this too would have its superior limit, and then the crop would attain the dignity of *high forest.** Some such classification would, no doubt, be useful to us, but I refrain from suggesting what the limits of size should be for the various classes, though it seems to me that diameter and not height should determine them.

When there is no crop at all on the ground, most of us at present employ the word "Maidan;" there is no occasion to do this, as we have the word *blank,* which can always be qualified by such adjectives as extensive, small, &c., and if the blanks are very small, and surrounded by forest, we may use the word *glade.* In case the blanks occupied a very large area, I would term them *treeless wastes.*

The word "reboisement" has been frequently employed in reports, official documents, &c., but it seems to me that either *re-stocking* or *re-wooding* answer the purpose equally well; one point in their favour is that they are English words, and thoroughly express the required meaning; another point is that we shall then be able to employ the verbs to *re-stock* or to *re-wood,* whereas we cannot very well say to *reboise.*

* This term has already been disposed of.—The Editor.

Note.

Some discussion took place at the Conference, and the following terms were generally agreed upon :—

Forest Treatment.

Working-plan.
Working circle.
Block.
Compartment.
Rotation.
Natural reproduction by seed.
Thinnigs—light, moderate, heavy.
Cutting.
Area cut—the area in which fellings have gone on in a given period.

Different classes of Forest.

High Forest.
Coppice with standards.
Coppice.

Different kinds of trees.

Conifers.
Leaf trees.
Shoots.
Suckers.

The following definitions of the various age-classes were also given :—

Thicket—when the young plants have not yet begun to clear their lower branches.

Saplings—when the young plants separate, and the bole begins to clear.

Poles—when the sapling has grown to a large size, but is still growing vigorously in height.

Young (or middle-aged) trees—when the main growth in height has ceased, but the increase in girth is still proceeding vigorously.

Mature trees—when the growth in girth has ceased to be of importance.

The words *blank*, *glade*, and *large wastes* were also agreed upon.

With regard to the terms, *block* and *compartment*, the meaning given to them in the foregoing paper was not sanctioned; a full explanation of these terms will however appear in the forthcoming Forest Code.

With regard to a few other terms, no satisfactory understanding was arrived at by the Members of the Forest Conference. These terms will doubtless settle themselves in time, but meanwhile a discussion in the pages of the INDIAN FORESTER would not perhaps be entirely fruitless.

Sm.

On the relation between District and Forest Officers.

By C. F. Amery.

At the Forest Conference, recently held at Simla, one of our colleagues attempted, on more than one occasion, to lead up to the subject of the relation between district and forest officers, but speaking only out of the bitterness of his heart, and without due preparation, he succeeded only in eliciting from the President the severe rebuke that he, the President, should consider that officer unfitted for his position who was unable to get along with the district authorities.

So unqualified a remark is, it strikes me, calculated to do more harm than good. Excess of zeal is a far less serious and less permanent fault than indifference, and although a forest officer, who allows himself to be drawn into unseemly altercations with the district authorities on official matters, or who, when commenting upon difference of views between himself and his district officer, assumes the existence in the latter of a feeling hostile to the Forest Department, lays himself open to deserved censure, his error is far more deserving of condonation than that of the officer who voluntarily sacrifices the best interests of his Department for the sake of working smoothly with everybody, and Dr. Brandis' remark above cited is calculated to provoke to this latter policy those officers whose sense of duty is outweighed by considerations of personal interest.

There is, and probably for years to come there will be, an antagonism of view between the two departments—an antagonism based both on antagonism of interest and difference of stand-point. Up to a very few years ago the district officer held sole control of all lands in his district, and the unoccupied lands were his chief means of conferring patronage; he could give or lease them, or confer or confirm privileges in them. If troubled with lawless tribes of budmashes he could offer them land as an inducement to settle to honest pursuits, and if a keen *shikari*, the forests were his sole and undisputed game preserves. Apart too from all departmental and personal interests, his stand-point is different, his recollection carries him back to days when the forest as such yielded so little revenue, that it was often as well to let the people help themselves to its products and graze their cattle in it, as to be at the worry and cost of collecting the revenue; when every acre broken up for cultivation yielded more revenue than a hundred acres of forest land, besides enlarging the capabilities of the district, and promoting the well-being of the people; to a time, when in fact the amount of forest broken up for cultivation, became the recognised measure of a district officer's capability and tact. The Forest Department by breaking fresh ground have brought to light some new facts. They have discovered that while the fuel and timber-consuming population is rapidly increasing, the forest area under the control of the State has been, and is still being, so rapidly contracted that already far below the proportion to culturable land, considered necessary to the general well-being in other countries, which like India have no great wealth in coal and iron to fall back on, there is room to fear that the future prosperity of India is in danger of being retarded by a scarcity of forest products, which in their own degree are as essential to the general well-being as food and water. Even the so-called State reserves are hampered by village rights of diverse character. Not only are all the ancient rights concentrated in the now contracted forests, but the new settlers on that forest area, which has been broken up, claim to exercise rights in the forest area that remains.

The district officer is generally ready to support these claims, he conferred the rights, it may be only *viva voce* or along with a yearly tenancy, but having conferred them he will not see them wrested from the people by a new department, which he believes animated by no higher motive than a satisfactory balance sheet, and so the forest officer sees in the district officer a man willing to sacrifice the lasting well-being of the empire, rather than allow the people to suppose that he has ceased to be all powerful in his district, while the district officer, in his turn, regards the forest officer as full of crude and ill-digested notions, ignorant of, and indifferent to, the wants of the people, a clog to all true progress, and the cause of innumerable petitions and disputes.

Again the forest officer regards the exclusion of fires as absolutely essential to the well-being of the forests—he goes to considerable expense to keep out fires; the district officer tells him that he fears it will be no use—that the people have always been accustomed to fire them to improve the grass, or rather to bring on a young crop quickly—that it would be difficult to punish them for an act they saw no harm in—that in fact there was no harm in it—that there have been fires from time immemorial—and that the forest persists and will persist in spite of them. The forest officer knows better—he is zealous and energetic too, but in spite of this he wakes one morning to hear the fire crackling in the distance, and to see his forests all ablaze. Sallying forth promptly, he discovers a couple of cowherds coming from the direction of the fire, lighted hookahs in hand, and straightway hauls them before the Magistrate. The accused deny the charge—there is no evidence, but the forest officers, and the Magistrate sums up shortly saying, that although a certain amount of suspicion attaches to the accused, there is no evidence that they fired the forest, still less that they fired it wilfully, and the case is dismissed. The forest officer, who has perhaps never been in a court before, takes exception to the verdict, is recommended to leave the court before rendering himself liable to punishment for contempt, goes home and writes an angrily-worded report to his chief, imputing improper motives to the district officer, thereby drawing down

upon himself a well-deserved *wigging*, and in the future is tempted to let matters take their own course, rather than earn a repetition of it.

But it will be said that with tact and temper the forest officer may always work well with the district officer. True, but he will not always carry his point. If the views gradually finding acceptance with the Forest Department are correct, district officers generally are not only not animated by them, but believe that they are wrong, and in this belief it is too much to expect that they should co-operate with us, nor can an appeal from the district officer be carried to higher authority, and won without causing a certain amount of unpleasantness, but a sense of duty should overrule all considerations of this nature.

There must be disagreement when there is honest diversity of opinion, and forest officers, if they have vision, and even insight, are but half articulate creatures, capable of crying out when they are opposed, but not generally capable of rendering intelligible the thing that they do see.

To place the forests again under the district officers would tend rapidly to smooth away the existing difficulties. Once more vested with sole authority over the land, and saddled with the sole responsibility of forest administration, they would subordinate their individual opinions to generally-recognised views of Forest Conservancy; fires, which cannot be kept out by the orders of the forest officer, supported by such assistance as he gets from the district officer, would cease directly the district officer ordered their discontinuance, and village rights ceasing to be a departmental question, would soon have their *status* defined, and be reduced to something like manageable proportions; but on many grounds, it would be inexpedient to take the forests out of the control of a specially-trained department, and we must simply wait patiently, until our infantile utterances have become sufficiently articulate sounds to make known to the highest authorities the things which we do see. Let us convince them that the tendency of our efforts is to secure the lasting well-being of the people, and we shall remove all obstacles to successful administration. The Government has been treated to too much speculative theory, and too

few hard facts, to warrant it in taking decisive measures for the rigid maintenance of the remaining forest reserves. *Having* convinced ourselves of the expediency of certain lines of conduct, we are endeavouring to give effect to them, while the Government remains but half convinced, and hence the support we receive when we come into collision with the district authorities is but half-hearted.

II. REVIEWS.

Report on Neilgherry Loranthaceous Parasitical Plants Destructive to exotic forest and fruit trees.

By George Bidie, M.D., Surgeon-Major, Superintendent, Government Central Museum, Madras.

[Printed by E. Keys, at the Government Press, 1874.]

IN almost all forests, there seems to be some great obstacle which has to be overcome before they can be placed on a proper footing. In the teak and sal forests generally that obstacle seems to be 'grass and the prevalence of jungle fires,' but in many cases, as in the Central Provinces, this obstacle has been fought against, with, at any rate, partial success. In the coniferous forests of the North-Western Himalaya the obstacle seems to lie in the destruction of seedlings by grazing owing to privileges enjoyed by the inhabitants of surrounding villages, but this being an artificial and not a natural obstacle is probably easier to encounter. In the babul forests of the banks of the Indus the shifting of the bed of that river and the uncertain state of safety of the forests, is the chief obstacle to the application of a continued working plan. Turning to plantations. In some parts of Scotland, notably Strathspey, the squirrels have multiplied to such an extent, and do so much harm to the young shoots of conifera as to make their destruction a matter of the first importance to the Foresters. In the larch forests too the ravages of dry rot, which have lately been so much discussed, but without result in the way of a preventive, have done incalculable damage, while, in India, we see our young toon trees eaten down year after year by insects, while we have but little means of preventing the damage without appliances too costly to be used. So it is with the valuable plantations of exotic trees in the Neilgherry Hills of the Madras Presidency, and the report before us treats of an obstacle, rather new in its way, *viz.*, the damage done by the epiphytic loranthaceæ to the trees.

The greater part of the report consists of a discussion on the species of Loranthus found on the trees of the Neilgherry plantations, and gives a list of the principal exotic trees upon which each species is found, which cannot fail to be interesting to the botanical student. We must, however, remark on the value of plates 3 to 9 as affording means in the ready identification of species. The subject of the system of propagation of the parasitical plant and its method of adapting to its own use the precis of its host is also discussed at length, but we can leave these discussions to a consideration of the points most important to the Forester, *viz.*, the nature of the damage done to the host by the parasite, and the best means of preventing this damage. The exotic trees, which seem chiefly to be attacked, are the *apple*, *pear* and *peach* and the *Acacia melanoxylon.* The *Eucalyptus globulus,* in whose welfare most of us seem to be interested, seems completely to escape, while the *Acacia dealbata* is only but slightly attacked. The reason for this preference, the author informs us, is, that while the bark of *Acacia melanoxylon* is rough and much cracked and consequently offers a safer resting place for seeds, that of the *Acacia dealbata* is comparatively smooth, and has less likelihood of the seeds attaching themselves. We should state that the seeds of the Loranthus are surrounded by a viscid substance which is either rubbed off by birds, who eat the outer covering of the fruit, rejecting the seeds, or which passes uninjured through their bodies, and so attaches itself to the tree.

With regard to the damage done by the parasites, Dr. Bidie states that their influence is not very marked unless they are large as compared with the size of the host, or unless the host is covered with such a number of them as to drain it almost completely of its sap. He says in para. 24: "The work of destruction proceeds as follows: One or more large branches get so covered with Loranthus that the whole, or nearly the whole, of the sap goes to the parasites, and thus the affected branches die of starvation, down to the trunk. Branch after branch perishes in this way, and at length the tree, bereft of its foliage and robbed of its sap, dies down to the root."

As to the effect on the timber Dr. Bidie says: "Although trees killed by parasites are quite useless as timber, the value as firewood is said not to be impaired. I am, however, doubtful on the latter point, and think it is one deserving of more particular inquiry and experiment. So far as my own experience goes as regards fir-timber, I know that trees that have died gradually of inanition, as parasite-affected trees in this country do, are comparatively worthless for fuel purposes." But the question, we may remark, here is: Would the trees ever be allowed gradually to die of inanition? Or would they not generally be cut before such a result took place? In the sal forests of the Sub-Himalayan tract we have often noticed large numbers of trees attacked by 'Loranthus,' but it never seemed to us that the wood was in any way unfitted for use, or that the trees gradually died of inanition. Such may however be the case, and may perhaps afford a clue to the reason of the prevalence of the large numbers of dry trees to be met with in the Northern Bengal sal forests; formerly this was put down to jungle fires, but lately it has been suggested that jungle fires are not always the cause of death; but only come afterwards and by clearing the tree give it the outward signs of having been killed by fire. This is a point deserving of further discussion. Turning to the means of preventing the ravages of these "Loranthi," we notice that in para. 30 Dr. Bidie discusses the question of excision of the part attacked. Excision however does not seem of much use, as we read that the stumped branches afford almost better resting places for the seeds than the bark of the tree itself, and so it seems more likely to increase rather than diminish the evil.

We cannot but regret that the report terminates so unsatisfactorily, and that the only definite remedy that Dr. Bidie can suggest, is to discontinue plantations of *Acacia melanoxylon*, as we consider it not yet satisfactorily settled that the Loranthi do sufficient damage to the tree as to render it unfit for firewood, when grown with a short term of rotation. We hope however that such an interesting subject will not drop, and that some forest officers may supply us with further informa-

tion on the subject, and especially with regard to *indigenous* trees, and among them our chief timbers,—the teak and the sal.

J. S. G.

Notes on Vanilla.

BY MR. O'CONNOR.

A pamphlet on the production of Vanilla by Mr. O'Connor has recently been issued from the Government Printing Press, Calcutta, which gives information on all the principal points of the culture and manufacture of this most valuable article, and certainly warrants the experiments which it recommends to be attempted in its cultivation in the Eastern and North-Eastern districts of India.

The pamphlet goes into the subject of the production of Vanilla at Bangalore, and contains an article published in 1861 in the journal of the Agri-Horticultural Society of India, and written by Monsieur de Floris of Reunion, giving full details of the cultivation and manufacture of Vanilla in the Isle of Bourbon, together with supplementary remarks on the same subject by Captain Lowther. The plant called Epidendron Vanilla is a creeper belonging to the family of orchids, and is a native of Central and of the warmer portions of South-America, from whence it has been introduced into various other countries, and especially into the Isle of Bourbon, where it has succeeded admirably, and now forms one of the principal articles of export. It might consequently, with all probability, be grown in the Andaman Islands, in Ceylon, and along the coasts of the Bay of Bengal, provided the spot chosen was sufficiently removed from the effects of the salt sea breezes.

The cultivation in India has been commenced in Bangalore under Colonel Buckle, and it has been found easy, and that the flowers fertilized freely, the artificial method of fertilization being indispensable.

It has even been introduced at Ootacamund where the plants flowered freely, but fruit has not been produced. A garden was opened out at Sibpoor on the Hooghly, but when the proprietor left the country, and sold his estate, it was allowed to go

into jungle. The plant has been known in Calcutta since 1835, and it has been grown in the Botanic Garden ever since, but owing to the ignorance of the need of artificial fertilization, as the insects of India have not yet appreciated its honey, it did not fruit at first. In 1855, however, fruit was produced, and owing to the favorable results obtained in Mysore, the Government of India has requested the Government of Bengal to resume its experimental cultivation in a thorough manner.

Mr. O'Connor anticipates success for the Vanilla in Assam, Burmah, and Lower Bengal, and considering the high value of the product, it should certainly receive a trial in different parts of these districts, as the extremes of average temperature do not vary more than in Bangalore, where good results have been obtained. As regards the commercial value of Vanilla, it is stated that the fruit, when prepared, has been used since the year 1720, as a flavoring essence and aromatic, especially for chocolate and cocoa.

Recently the pods which yield a fine brown color have come into demand for dyeing purposes in Germany, and this employment will give more strength and fixity to the trade.

The price obtained for good qualities of Vanilla is very high, and it is stated that good Mauritius pods were quoted last year at 80 to 90 shillings a pound, in the London market. As the price is now 25°/o above the average, it is evident that the demand is far beyond the supply.

That grown in Bangalore was only quoted at 10 shillings per lb., but this low price is attributed to the imperfect system of preparation owing to ignorance of the proper method, and profiting by experience it is hoped that Bangalore will produce as good Vanilla as Bourbon.

In reporting on some pods produced in the Calcutta Botanic Garden in 1855, a leading firm of London confectioners estimated the value at 50 shillings per lb.

The Vanilla industry in Bourbon has attained large dimensions, and in 1871 nearly 40,000lbs were exported, being valued at £100,000.

In a report by Captain Lowther to the Agri-Horticultural Society of India in 1861, it is stated that a plantation of Vanilla

in Bourbon, of only one acre in extent, yielded 15,000 francs or 6,000 rupees in one year.

Much labor is not required in this industry, and ten laborers, whose services are not required throughout the year, are sufficient for the production of above 1,000lbs weight of the pods. As regards the cultivation in Assam, the Valleys and low Hills in Kamrup would be admirably adapted, and if natural forests were not preferred, large cuttings of several species of trees succeed at once, or plantations of rapidly growing trees can be formed from seed in one or two years, so that there would be no difficulty as regards the shading and supports.

A plant of Vanilla grown in Colonel Campbell's compound at Gauhati, in 1865, and clinging to a Kaddam tree, (*Nauclea cadamba*), attained to a height of 30 feet in two years and six months; it also flowered freely, and appeared most healthy. As the artificial method of fertilization was unknown, no fruit was formed, but Colonel Campbell states that the growth was most luxuriant, and quite unaffected by the cold, which in Gauhati attains a minimum of 44°.

The Kaddam would be admirably adapted for shade and support, and a seedling in Darang, only 4 months' old, attained a height of 15 feet 8 inches, with a girth at base of 9½ inches, so that no delay would be occasioned in getting up this necessary protection. The pan house system recommended by Mr. O'Connor would involve considerable expense both in construction and also in removal of the roof in case of rain, as the drip would certainly be prejudicial to the plants unless the roof were constantly removed during a heavy rainfall.

We await with interest the results of the experiments under progress in the Calcutta Botanic Garden, and can recommend Mr. O'Connor's pamphlet to the attentive study of our readers.

W. R. F.

III. NOTES AND QUERIES.

A few notes on the nursery treatment of Deodar, Chil, Chir, Ban, Horse Chestnut, Walnut and Alder, Acacia and Gum, by MR. CRAW, *Superintendent of Forest Nursery, Ranikhet.*

DEODAR.—In this country Deodar is best sown soon after the seed ripens or early in December. The ground for seed beds should be light loam or what is termed good garden soil. Heavy clay soil, which binds in wet, and cracks under the hot sun of April and May, should be avoided. The grounds should not be manured—only carefully hoed 15 inches or 18 inches deep and levelled, and the seed sown in broad *shallow* drills 8 inches apart. Should the spring prove dry, the beds will require to be watered before the seed germinates, but this is not always necessary. When the seeds germinate and water is required, it is better to give a good copious watering once in two or three days than a little every evening, the good effects of which is quite nullified by the next day's sun. By July the young plants are sufficiently large to handle, and should then be transplanted in nursery lines, 9 inches apart and 6 inches in the lines. This work is best performed by stretching a line and cutting along it a trench with a hoe or a spade, and against the smooth surface of the bank (which should be as perpendicular as possible) thus formed, the young plants are placed and supported by a handful of earth, care being taken to first fully extend their roots against the bank. The remainder of the earth being then replaced and levelled. This is much better than transplanting by dibble, the hole made by which is ferquently too shallow, the roots are thereby curled up and the plant makes no progress.

By next rains the plants must again be transplanted in lines 15 inches apart and 1 foot in the lines, care being taken to remove them with a little ball of earth adhering to their roots.

The same care must be observed to fully extend their roots in the trench, and the ground should be pressed firmly about the roots to steady the plant. The plants soon establish themselves, and nothing further is required than to keep them free from weeds. By the following rains, the third year from sowing, the plants are ready for removal to the forests.

CHIL (*Pinus excelsa*).—The same treatment as for Deodar applies to this tree in the nursery.

CHIR (*Pinus longifolia*).—The seed of this tree does not ripen until March or April according to situation. Sow then and transplant as directed for Deodar.

BAN-OAK (*Quercus incana*).—Collect acorns early in December; gather from the tree, and not those that have fallen, which are generally worm-eaten. Any ordinary good soil prepared as directed for Deodar will suffice for the Oak. Sow like peas in broad drills a foot apart and 3 inches deep; keep free from weeds during the summer rains. During the *second* rains from sowing take up the young plants, lightly trim their roots, and transplant in lines 15 inches apart and 9 inches in the lines. Again weed and occasionally stir the surface of the soil, and during the following rains remove to the forest if the planting is near at hand; if very distant, again remove into nursery lines in rather poor soil, and transplant in the forests next rains. Oak succeeds best when transplanted during the rainy season.

HORSE-CHESTNUT (*Pavia indica*).—Soon after the seed ripens, in November or December, sow in good rich soil in drills a foot apart, 3 or 4 inches deep, the seeds 6 inches apart. Keep free from weeds during the rains, and when the young trees shed their leaves in the cold weather take them up, lightly trim their roots, and transplant in good soil, in lines 18 inches apart and 1 foot in the lines. Occasionally stir the surface of the soil during the hot weather. No watering is required; keep free from weeds. In the cold weather the plants are fit for removal to the forest. They should be taken up without any earth adhering to their roots, which in the case of distant planting is a convenience and saving.

WALNUT (*Iuglans regia*).—The same treatment of sowing, pruning the roots and transplanting, as directed for the Horse

Chestnut, applies to the Walnut. These trees, in fact all deciduous trees, are best transplanted during the cold weather.

ALDER (*Alnus nepalensis*).—This should be sown in the end of February or beginning of March in very shallow drills, a foot apart, on level ground. After sowing, the ground should be covered lightly with ferns or grass and watered occasionally until the seed germinates, after which gradually remove the covering and weed, water and stir the soil as directed for Deodar. During the following cold weather take up the seedlings, trim their roots with a sharp knife, and transplant in lines as directed for Horse Chestnuts and Walnuts. The plants, as in the case of Horse Chestnuts and Walnuts, are fit to remove to the forest the second cold weather from time of sowing.

ACACIA.—Choose a good friable soil, which, when dry, dig about 18 inches deep. If the land is not level, it should be formed into small terraces, according to the lie of the ground, and across the terraces make beds 4 feet wide with 18-inch paths between. Sow in fine weather, early in February, in shallow drills across the beds and 8 inches apart. If the weather proves dry, the beds must be well watered as directed for Deodar, and when the young plants appear they should be kept free from weeds and the soil between the drills frequently stirred with a small Dutch or draw-hoe. All watering, weeding, and hoeing should be performed from the paths and the beds not needlessly trod upon. By the middle of July, being then 6 inches to a foot high, the seedlings will be ready to transplant. Any ordinarily good ground, level or sloping, will do to transplant in, but care should be taken to avoid places subject to severe hoar frost. Take up the seedlings, line by line, with a digging fork, separate them into two sizes, and plant—the largest in one plot on lines 15 inches apart and 1 foot in the lines; the smaller plants put on another plot, on lines 1 foot apart and 9 inches in the lines, and afterwards keep free from weeds. By the following rains the plants will be ready to remove to the forests or plantations.

EUCALYPTUS.—Sow as directed for Acacias.

About the middle of July take up the seedlings, separate them into two sizes, and plant as directed for Acacias, and, as

in their case, also carefully avoid low damp places subject to severe hoar frost. Choose wet days for the work, and when the plants are established and weeds appear, hand-weed the lines, or, if a few fine days occur, first lightly hoe between the lines. Never allow weeds to over-top the plants, or they will be drawn up weakly, and be unable to withstand the winter without protection. By the following rains the plants will be ready to remove to the plantations. If the plants are required for very exposed situations, instead of sowing the seeds in February defer it till July, and then sow in sandy or gravelly soil, sloping gently to the east. Line off the beds across the slope, inclining a little one way for the paths to carry off heavy rain. The beds should not be level but sloping like the land and raised a few inches by means of the earth taken from the paths. Sow the seeds in very shallow drills across the beds, and when the young plants appear, keep them free from weeds. About Christmas, or when snow is apprehended, cover the beds with grass tatties, raised 18 inches from the beds. This covering should remain until the middle of February, or later if very cold and exposed. If the spring is dry, well water the beds three times a week, or oftener if necessary, occasionally stirring the soil between the drills to prevent its caking; and, when the rains set in, take up the seedlings, separate them into sizes, and plant as directed for spring-sown ones. Afterwards keep the plants free from weeds and remove to the plantations the following rains.

Unless the soil and situation are very favorable, the several kinds of gums should not be planted over 6,000 feet. Above this height they are liable to be broken by heavy snow lodging upon their tops and branches and weighing them to the ground. This year at Dunagiri, at an elevation of 6,500 feet, two large blue gums, 10 years old and over 60 feet high, were broken short above the ground by snow lodging upon them; younger plants of the same variety at a similar elevation at Ranikhet were also broken, while leafy plants of the same kind, five years old, at an elevation under 6,000 feet, escaped, their leaves being smaller and not so dense. Acacias are not so easily broken, and may therefore be planted at a slightly higher elevation than that

recommended for the gum; but care should be taken in planting either trees to avoid damp dells or flats subject to severe hoar frost. Of gums, the blue and iron bark (*Eucalyptus globulus* and *cideroxylon)* are the best sorts to plant in the hills; and of Acacias, *decurrens* and *melanoxylon.*

NAINI TAL; *The 2nd September* 1875. G. GREIG, *Offg. Conservator of Forests, N. W. P.*

Climatic changes in Russia.

The following notes are taken from an article by Professor Palingsestow "on the climatic changes observable in Russia:" The winters, he says, are getting rougher every year; the summers hotter, drier and more sterile. In Bokhara and Taschkend the people say that the Russians brought the severe winters from their home, and in 19 districts the harvest reports are unfavorable, and even bad. The origin of these climatic changes Palingsestow proves to be the cutting down of the forests. Former-

panicle. As a corn-plant, however, no attention has yet been paid to it either in Europe or America; whilst, as a sugar-yielding plant, it has obtained an important place in agriculture."

From the above I think it would thrive well in the hills; and it is my wish, if I can only procure some of the seed to introduce it into Bussahir, where no sugar of any kind can be procured. The seed should be sown as soon after the frosts have disappeared as possible, in rows about 4′ apart, and the plants thinned out to about 12″ to 18″ in the rows. In its infancy it grows very slowly, so great care must be taken not to allow weeds to choke it; afterwards it grows very rapidly. In America 100,000 acres yielded 16,000,000 gallons of syrup. Although a perennial, owing to the intense cold during the winter months that prevails in the Hills, I think it will have to be treated as an annual.

In conclusion, I sincerely hope that Government will take the matter up, as it is well worth its consideration, and allow us to give it a fair trial.

C. E. TENDALL,

S. A. C.

Chinese Blackwood in Bombay.

At page 52 of the *Indian Forester* B. H. B. P. asks what species of tree is indicated by the name of Chinese Blackwood, and how seed can be obtained. I cannot state the correct botanical name of the tree referred to. I can tell, however, how it acquired the name of Chinese Blackwood. The tree, or rather shrub—for it does not appear to grow beyond 12 or 15 feet in height, and has several stems—was several years ago brought to Dharwar by the then Collector, Mr. Law, a well-known botanist. He obtained the seed of the tree from China. I know nothing of botany, but have always taken a great interest in tree planting. When I came to Dharwar I noticed several of these trees; they are rather handsome when in flower. I inquired the name, and was told it was a Blackwood obtained by Mr. Law from China. From that day it went by the name of the "Chinese Blackwood." Four years ago, finding two of these trees occupied a portion of grass ground on which I desired to plant some fine trees, I had them cut down and the main roots removed. Ever since then they have been a continual trouble and nuisance. Young plants from the old roots spring up in every direction, no matter how hard or bad the soil. Still up they come as soon as the rain falls. I have removed hundreds, and there they are again this year as plentiful, if not more plentiful, than ever. They seem to thrive in hard gravel or anywhere. It appears to me that if only 8 or 10 of these trees were planted to an acre, and then when about 6 feet high cut down, there would in a few years be a thick scrub jungle

yielding plenty of excellent firewood. Bare hills could be re-planted with this shrub and in many places it would be a blessing to the people affording an ample supply of firewood and doubtless benefitting the rainfall.

If B. H. B. P. will give me his address I shall be happy to send him a supply of the seed.* I have never tried this shrub in good soil, but there perhaps it might grow into a large tree.

E. P. ROBERTSON, Bom. c.s.

* B. H. B. P. is at present on leave in England, but he will doubtlessly see this communication.—*The Editor.*

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Bamboo and its use.

BY S. KURZ.

(Continued from Vol. I., No. 3, page 269.)

III. SPECIES OF BAMBOO.

Col. Munro, in the 26th volume of the Linnean Transactions, has published a monograph of all the bamboos known to him. Previously to him, in 1839, Prof. Ruprecht, in the Transactions of the Academy of St. Petersburg (Ser. VI., vol. V., part 2) has furnished us with an admirable account of the bamboos. These two works form now the foundation of all systematic work in bamboos. My own studies of this group were commenced in the Botanic Gardens, Buitenzorg (Java) many years ago; but owing to the difficulties I have experienced in procuring the different species of bamboos growing in British India, and owing to my desire of studying them all in nature instead from dried specimens only, I have thought it necessary that I should for the present treat only the bamboo of those countries of which I have the best material for study at hand. These are chiefly the bamboos of the Malayan countries, of which such a fine living collection exists in the noble Botanical Gardens of Java. At the same time I may be allowed to acknowledge the obligations under which I stand to Mr. J. E. Teysmann, the late Director of the Java Gardens, and at present Honorary Inspector of Cultures, to whose energy and disinterestedness I have to thank so many valuable additions to my knowledge of bamboo generally.

a.—BAMBOOS OF THE INDIAN ARCHIPELAGO AND MALAYA.

Col. Munro, in his monograph above cited, enumerates 30 species of bamboo as occurring in the Indian Archipelago and

the Malayan countries, but not a few of them must be deducted, as they are founded either upon incomplete materials or upon Rumphius' works. These are: *Bambusa tenuis*, Munro; *Bamb. amahussana*, Ldl.; *B. Horsfieldii*, Munro; *B. atra*, Ldl.; *B. fera*, Miq.; *B. maxima*, Poir.; *B. picta*, Ldl.; *B. prava*, Ldl.; *B. teba*, Miq.; *B. vasaria*, Munro; *Bambusa bitung*, Roem and Schult.; *Melocana humilis*, Roep., and *Schizostachyum Blumei*, Munro, not of N. E. Thus there remain only the following legitimate species for the Indian Archipelago and the Malay countries, *viz.*: 1.—*Bambusa Rumphiana*, Kz. (*B. tenuis*, Munro; *B. amahussana*, Ldl.; *B. atra*, Ldl.; *B. picta*, Lindl.; *B. prava*, Ldl.) 2.—*B. cornuta*, Munro (*B. Horsfieldii*, *Munro*). 3.—*B. nana*, Roxb. 4.—*B. Blumeana*, Schult. (*B. Teba*, Miq). 5.—*B. vulgaris*, Wendl. (*B. fera*, Miq). 6.—*Gigantochloa verticillata*, Munro (*B. maxima*, Poir; *B. vasaria*, Munro). 7.—*G. atter*, Kz. 8.—*G. heterostachya*, Munro. 9.—*Schizostachyum chilianthum*, Kz. (*M. gracilis*, Kz). 10.—*Schiz. elegantissimum*, Kz. (*Beesha elegantissima*, Kz). 11.—*Dendrocalamus strictus*, Munro. 12—*Dend. flagellifera*, Munro. 13.—*Dend. giganteus*, Munro. 14.—*Dinochloa Tjangkorreh*, Buse. Besides the above, Col. Munro enumerates *Oxytenanthera nigro-ciliata*, Munro, under which name he confounds 3 or 4 perfectly distinct species; and *Melocanna Zollingeri*, Kz., a species similarly made up of 3 or 4 equally distinct species. Entirely doubtful must remain *Melocanna humilis*, Roep., which nobody will be able to identify unless he studies the Moluccan species on the classical ground. Munro's *Schizostachyum Blumei* is a new species from Hindostan, which I have named *Sch. Hindostanicum*.

The number of species (although some without flowers) known to me to grow in the Malayan area amounts to 24 only, of which however one (*B. nana*) is an introduction from China or Japan. As soon as the Flora of Celebes, the Moluccos, etc., shall become more explored, many species will have to be added. The species are distributed over the following few genera (some of Munro's genera I am obliged to reduce), *viz.*: *Bambusa*, *Gigantochloa*, *Dendrocalamus*, *Schizostachyum* and *Dinochloa*, which all belong to the hexandrous group of bamboo, having only 6 stamens. I let follow here a conspectus of them

with their distinctive characters. As these characters are all based upon the floral parts and fruits, the practical forester rarely can avail himself of these—a thing which is to be regretted, but naturally cannot be helped.

* *Fruit small with a membranous pericarp closely adnate to the seed, and thus resembling oat or wheat; style deciduous; inner palea boat-shaped and 2-keeled.*

Bambusa.—Filaments free. Spikelets usually glossy, pale green to steel-blue, in a dried state straw-coloured.

Gigantochloa.—Filaments united into a tube. Spikelets usually dull-green or purplish-green, opaque.

** *Fruits often rather large, the pericarp separating already before ripening into an outer firmly coriaceous, usually glossy coat, while the inner cellular tissue separates and closely embraces the seed; style persistent, or rarely caducous.*

† Inner palea boat-shaped and 2-keeled. Fruit dry; glossy.

Dendrocalamus.—Style collapsing in fruit, the latter more or less terete.

†† Inner palea concave or convolute, not keeled.

Schizostachyum.—Inner palea convolute, elongate. Fruit somewhat compressed, very long and stiff-beaked. Erect arboreous or shrubby bamboos.

Dinochloa.—Inner palea concave, shorter than the outer one. Fruit terete, ovate, acuminate. Lofty climbers.

I will not undertake to give full technical characters of the genera and species, for such are rarely consulted by the practical forester; but as regards the species I will cursorily mention not only the more prominent botanical characters, but also the distinctive characters used by natives. These latter are specially useful for practical men, inasmuch as they are not based upon floral parts, but upon the shoot-sheaths, general habit and nature of the halms. I shall omit also synonyms, but give a general account of the distribution of the several species.

For the exhibition of botanical characters no method appears to me more satisfactory for the use of practical men than the tabular form usually called an analytical key, which not only gives the differential characters, but also arranges the several species according to the degree of natural affinity. Artificial

keys are handy in certain respects, but slight errors that may creep in may lead the inquirer far astray; besides they appear to me the most mechanical and unnatural method to which a reasoning man can take resource. I must mention here that there remain a good number of species which I was not fortunate enough to study in nature in spite of the trouble I have often taken of obtaining an opportunity of doing so: hence I was naturally compelled, when framing the analytical keys, to take advantage of collateral characters in the absence of the essential ones.

Genus BAMBUSA, Schreb.

Conspectus of the species.

Subg. 1.—*Ischurochloa.*—Outer paleas concave on the back. Lodicules well developed.

* *Rachillae elongate, hence the florets loosely arranged without hiding the rachillae*

† Unarmed. Stigma white.

Shrubby; shoot and leaf-sheaths green, glabrous, sparingly fringed at the mouth, not or only obsoletely auricled ... *B. nana.*

Arboreous; shoot-sheaths coloured, appressed brown-bristly, fringed on the auricled mouth ... ... *B. vulgaris.*

†† Thorny bamboo. Stigma purple.

Arboreous; halms smooth, glossy; shoot-sheaths coloured, dark-brown, bristly all over, strongly setose-fringed at the auricled mouth ... ... *B. Blumeana.*

** *Rachillae short and hidden, hence the florets very crowded and close.*

Arboreous; halms grey—tomentose, much fibrose-rooted at the prominent nodes; shoot-sheaths greyish bristly, rigidly fringed at the auricled mouth; stigmas purple ... *B. aspera.*

Half scandent; leaf-sheaths at one side of the mouth produced into a long slender auricle fringed at the thickened end; stigmas white ... ... *B. corniculata.*

SUBG. 2.—*Leleba.*—Outer paleas keeled, compressed, densely imbricate. Lodicules none.

Shrubby, large leaved ... ... *B. Rumphiana.*

1.—BAMB. NANA, Roxb. (*B. floribunda*, Zoll.)

A small shrubby species 6 to 10 feet high with glabrous halms about as thick as a finger; the shoot-sheaths glabrous and continuous with the leafy erect imperfect blade, minutely fringed on the minute auricles of the mouth; leaves small, glaucous or almost white beneath; spikelets in very poor panicles or almost solitary, above an inch long; the inner palea and the lodicules (these latter often fleshy) nude; stigmas white.

Originally introduced from China and Japan; it is now cultivated all over the Indian Archipelago and the Malayan countries, and forms beautiful dense hedges. It occurs at present also occasionally in a half-wild state on Java and Singapore, and probably elsewhere. It grows there much larger and vigorously at elevations between 2,000 and 3,500 feet.

This bamboo varies greatly in leaf and palm, but as these varieties are all introductions from China or Japan, they will be treated when I come to describe the bamboo of those countries.

Its Malay name is bamboo tjeenah aloos, also bamboo hower tjeena.

2.—BAMB. VULGARIS, Wendl. (*B. Thouarsii*, Kth.)

Arboreous, 30 to 60 feet high and higher, the halms strong, smooth and glossy; shoot-sheaths appressed dark-brown bristly, striped, rigidly fringed at the auricled mouth; leaves rather small, green; spikelets 5 to 8 inches long, in ample panicles; inner palea ciliate on the edges; anthers purple; stigmas white.

A fine species, of which the Malays distinguish the following varieties:

Var. 1.—Bamboo hower hedyoo, or bamboo hower gullies, also bamboo ampel, has uniformly green halms and branchlets.

Var. 2.—Bamboo hower konneng, also bamboo koonieng (yellow bamboo), usually with uniformly yellow halms, or rarely the one or other green and yellow striped.

Var. 3.—Bamboo hower seh-ah, also bamboo kooda, mal.; has the halms beautifully yellow and green striped.

Var. 4.—Bamboo tootool (blotched bamboo), the halms at first green as in the normal form, but turning black-blotched with age.

A very common bamboo in Java, where it grows abundantly in the bamboo-region between 1,500 to 3,500 feet elevation, preferring the sunny shrubby grasslands. But it is seen also everywhere in the plains cultivated as well as wild. At elevations above 3,000 feet it remains low, and the halms become only about an inch thick. Common also on the other islands of the Archipelago from the Moluccos and Celebes westwards to Singapore. This bamboo is at present much cultivated on the Indian Continent, Mauritius, the Cape and even in tropical America.

3.—Bamb. Blumeana, Roem and Schult. (*B. spinosa*, Bl. and of the Dutch botanists, but not of Roxburgh).

An arboreous species 30 to 60 feet high and higher, with very strong glossy smooth halms as thick as an arm, the branches abundantly armed with small recurved spines; shoot-sheaths violet brown, yellowish striped, covered with dark brown appressed or almost spreading bristles, with an erect continuous imperfect blade, long and strongly fringed on the decurrent large auricles; leaves small, green; spikelets very laxly flowered, forming large panicles; inner palea minutely ciliate on the edges; lodicules ciliate at the apex; anthers and stigma purple.

This kind is common enough in Java, but becomes more common eastwards, as on Balie and the Eastern Islands as far as the Moluccos; also on Sumatra, Singapore and Borneo. Of this a variety is occasionally found, the spikelets of which become nearly 2 inches long.

The Malays call this bamboo dooree or bamboo hower tyook tyook.

4.—Bamb. aspera, Poir.

A gigantic bamboo 60 to 90 and up to 120 feet high, the halms greyish tomentose, densely fibrose-rooted on the nodes up to ⅜ of the entire length of them; shoot-sheaths appressed grey bristly, rigidly fringed at the auricles; inner palea white ciliate on the edges and the angles; anthers yellow; stigmas purple; fruit not larger than a mustard-seed, oblong.

This bamboo is in all respects (also in the structure of the spikelets) a *Gigantochloa*, but has the filaments free. It produces the strongest halms, and is, therefore, extensively cultivated all over the Indian Archipelago as far to the north as Malacca. Along the base of the Java hills, at 2,000 to 4,000 feet elevation, it forms extensive forests along with bamb. andong and bamb. atter, in which the rasamala trees (*Altingia excelsa*, the prince of the Java forests) attain their greatest development, just as teak does in the Burmese bamboo-jungles, and how lofty these rasamalas there grow may be best imagined when I say that they push their heads far above the bamboo forests of 100 to 120 feet height.

It is generally known under the Malayan name of bamboo bitoong.

5.—BAMB. CORNICULATA, Munro (*B. Horsfieldii, Munro.*)

An half-scandent bamboo up to 30 feet high, which has the nodes of the branches patellate-dilated; leaves rather small, green; their sheaths produced at the one side of the mouth into a peculiar tail-like auricle 2-3 lin. long and fringed at the broader end; spikelets 3-5 flowered, short; inner palea ciliate on the keels; anthers yellow; lodicules nude and entire; stigmas white.

A very distinct species of the habit of which is very little known besides what the late Zollinger has furnished us with. It occurs in the eastern drier parts of Java chiefly and is there called bamboo nanap.

6.—BAMB. RUMPHIANA, Kurz. (*Leleba Rumphiana*, Kurz, formerly).

A very curious large-leaved shrub 6 to 15 feet high, the halms about 1 to 3 inches thick, very hollow, and only simply (not *whorled) branched, glabrous; shoot-sheaths spreadingly bristly*, rigidly fringed on the auricles; leaves very large, often spuriously half-stemclasping with their bases and almost sessile; spikelets very compressed, often twistedly elongate; the outer paleas sharply compressed, keeled; the inner ones ciliate on the edges; anthers yellow; stigmas white, but purplish pilose.

Of this species there are numerous varieties, some of them pretty differently looking. Rumphius enumerated these already in his Herbar. Amboin., *viz*:—

Var. 1.—Leleba dyahat or ootan, mal; utte aul boppo, Amb; halms about 1 to 3 inches thick, green, much branched; leaves much larger.

Var. 2.—Leleba pootee, mal.; utte aul tuni, Amb.; as former, but halms becoming whitish in drying.

Var. 3.—Leleba ietam, mal.; utte aul mette, Amb.; halms as thick as a finger, less branched, green or dark-green; leaves smaller, and not half stemclasping at the base.

Var. 4.—Leleba tootool, mal.; tapile, Amb.; as preceding, but halms with dull rose-coloured blotches.

Var. 5—Leleba soorat, mal.; as preceding, but the halms with pale-coloured and dull rose-coloured stripes.

This species will very likely turn out to be really a distinct and good genus when once the fruits shall have become known. It does also not grow inland like other bamboos, but in the marshy coast forests of the Moluccos. It is a free flowerer without dying off in the way of other bamboo. It abundantly flowers in the Botanic Garden of Java and now also in that of Calcutta, without however setting any fruit.

Genus GIGANTOCHLOA, Kurz.

Subg. 1.—*Gigantochloa proper.*—Spikelets oval to oval lanceolate; paleas gradually shorter down and upwards; anthers apiculate. Fruit oblong to ovoid. Gigantic bamboos, 60 to 150 feet high; the halms for $\frac{2}{3}$ from the ground free of branchings.

Halms almost glabrous, equal at the nodes; shoot-sheaths appressed fulvous-hispid, rigidly ciliate at the auricled mouth, the ligule erose-ciliate ... ... *G. maxima.*

Halms almost glabrous, green, the nodes not prominent; shoot-sheaths appressed blackish hispid, strongly and rigidly fringed at the auricled mouth; the ligule hispid fringed ... *G. robusta.*

Halms greyish green to blackish, glabrous; shoot-sheaths appressed blackish hispid, fringed on the auricled mouth; the ligule minutely ciliate ... ... *G. atter.*

Halms roughish, grey, usually covered with the dried-up shoot-sheaths, the latter appressedly

black-brown bristly, naked or nearly so at the mouth, the *imperfect blade constantly reflexed* ... *G. apus.*

SUBG. 2.—*Oxytenanthera*, Munro.—Spikelets elongate; the paleas upwards longer; anthers bristly terminated. Fruit elongate-cylindrical. Arboreous, usually branched from far below.

Halms glabrous, green; shoot-sheaths appressed brown bristly, fringed at the auricled mouth; outer paleas on the margins, the inner ones on the keels, densely fuscous-ciliate; anthers and stigma purple ... ... *G. nigrociliata.*

1.—GIG. MAXIMA, Kurz. (*Gig. verticillata*, Munr.)

A gigantic bamboo, 60-120 feet high; the halms as thick as a man's thigh, almost glabrous and the nodes not prominent; shoot-sheaths appressed tawny-bristly, rigidly fringed at the auricles; the imperfect blade reflexed; inner palea ciliate on the edges; anthers yellow; stigmas white.

An imposing bamboo like *Bamb. aspera*, and usually growing in society with it or forming forests for itself in the bamboo region of the Javanese hills. Also generally cultivated, and, indeed, never missed in any Malay village all over the Indian Archipelago from the Moluccos to Singapore and Malacca.

Its Malay name is bamboo andong, also bamboo gombong and bamboo dyawa; awie soorat in Sunda.

There are two varieties generally distinguished by the Malays, but the differences are more in size than in other characters. They are the following:—

Var. 1.—Bamboo andong besár. The large andong, has the tallest halms as thick as a man's thigh and thicker; spikelets up to 6-7 inches long, green.

Var. 2.—Bamboo andong ketyeel, *i.e.*, the small andong, shorter and less thick, the spikelets scarcely half as long, more blunt, often purplish.

N. B.—Col. Munro identifies Willdenow's *Bamb. verticillata* with the above, but I doubt the correctness of the identification, the more so as the Javanese name tring atter is given which indicates Gig. atter, a species difficult to distinguish from the above, from Herbarium material only.

2.—Gig. robusta, Kurz.

Arboreous big bamboo 70 to 90 feet high; the halms almost glabrous and the nodes not prominent; shoot-sheaths appressed black-brown bristly, strongly and rigidly fringed at the auricled mouth; the ligule hispid fringed; the imperfect blade spreading; leaf-sheaths white hispid, rigidly fringed at the minute auricles; flowers and fruits unknown as yet.

This bamboo occurs only in the hilly regions of Java, as in Bandong, in Buitenzorg south of Jasinga; also in Bantam. Malay name: bamboo wooloong.

3.—Gig. atter, Kurz. (*Bamb. atter,* Hassk.)

Arboreous, 30 to 70 feet high; the halms glaucous green to black, equal at the nodes; shoot-sheaths appressed black-brown bristly, fringed at the auricled mouth; the ligule minutely ciliate; the imperfect blade erect; inner palea ciliate on the keels; anthers yellow or purple; stigmas white.

Very common in the hilly parts of Java, at 2,000 to 4,000 feet elevation, forming whole forests. Like most other useful bamboo generally cultivated all over the Archipelago from the Moluccos to Sumatra and Singapore. Malay name: bamboo atter or bamboo taman.

There are two varieties of this bamboo, the one with glaucous green halms, the proper bamboo atter; and bamboo ietam, the black bamboo, with halms blackish green to purplish black.

4.—Gig. apus, Kurz. (*Schizostachyum apus,* Steud.; *Bamb. apus,* Roem and Schult.)

Arboreous, 30 to 60 feet high, the halms as thick as an arm, equal at the nodes, roughish, usually covered with the dried-up shoot-sheaths; the latter appressedly black-brown bristly, nude or nearly so at the mouth; the imperfect blade constantly reflexed; leaves large, their sheaths appressed bristly, glabrescent, smooth on the minutely auricled mouth; flowers and fruits unknown.

This is one of the most common species of the Indian Archipelago, easily recognised from long distances by the leaden grey and even whitish to leaden bluish halms covered with the

dried-up shoot-sheaths. Its flowers are still unknown, and I have referred the species to *Gigantochloa* solely by guess. It *may turn out to be referable to Oxytenanthera with which it* agrees better in general habit. It ascends up to 4,000 and 5,000 feet elevation, but grows best in the plains. At elevations above 3,000 feet it remains low and forms thin halms only. While young it is usually called bamboo talie (string-bamboo), because in this state it is chiefly used for strings, ropes, etc.; fullgrown it generally goes under the name of bamboo apoos.

5.—Gig. nigrociliata, Kurz. (*Bamb. nigrociliata*, Buse.)

Arboreous, 60 (according to Zollinger up to 130) feet high, *the halms green and almost glabrous; shoot-sheaths appressed* darkbrown bristly, fringed at the auricled mouth; the imperfect blade spreading; spikelets 1-1¼ inches long; paleas rigidly dark-brown or blackish ciliate, the inner ones from the middle tawny whitish ciliate on the angles; stigmas purple.

Frequent in Eastern Java, also on Balie and other islands to the east. Its name is bamboo lengka in Malay, but Zollinger gives it also (probably erroneously) the name of bitoong. In habit it greatly resembles *Gig. atter*, from which it is difficult to distinguish without spikelets or shoot-sheaths.

Doubtful Species.

6.—Gig. heterostachya, Munro.

Said to have slender halms, 30 feet high; spikelets of two kinds, compressed, resembling those of a *Bromus*, often 12 to 15 inches long, in terminal panicles; lodicules long-fringed; anthers terminating into an hirsute penicillate pilose bristle; ovary long-beaked.

A species which can hardly belong to the genus according to Munro's description, and it may probably turn out to be a *Teinostachyum*. It comes from Malacca, Ayer pannas, about houses.

Genus DENDROCALAMUS, N. E.

Paleas all sharply spiny-pointed; spikelets straw-coloured, usually pubescent, in dense large clusters; shoot-sheaths truncate at the mouth

and there furnished with a few hairs or nude; low arboreous bamboo ... ... *D. strictus.*

Paleas mucronate only; spikelets dull-green to purplish-green, almost glabrous; shoot-sheaths appressed tawny bristly; the imperfect blade wavedly decurrent and hardly fringed at the base; large arboreous bamboo ... ... *D. giganteus.*

1.—Dendro. strictus, N. E.

A small bushy bamboo, 20 to 30 feet high, the halms green and glabrous; shoot-sheaths more or less appressed tawny bristly, sparingly fringed or nude at the truncate mouth; spikelets in dense large clusters, 5-6 flowered, usually white hairy, forming panicles; outer paleas subulate-spiny, straw-coloured in a dried state; anthers yellow; stigmas purplish.

A xeroclimatic species which is common on the Indian Continent, but does not go further south than Upper Tenasserim. Buse, however, gives Java (Pandahan) as a locality, and Munro identifies a form with very large flower-clusters from Singapore as the above species. The matter requires further inquiry, and I have, in the meantime, made up the above description from Indian specimens.

2.—Dendro. giganteus, Munro.

A large arboreous bamboo, 60 to 100 feet high, the halms pruinose and attaining up to 2 feet and more in girth, the nodes not prominent; shoot-sheaths sparingly appressed fulvous-bristly; the imperfect blade wavy decurrent and hardly fringed; the ligule erose-shaggy, but not fringed; spikelets ovate, green or purplish green, 6 to 9 lines long, clustered and forming large panicles; inner palea long-fringed on the keels and hirsute on the back; anthers yellow; stigmas white.

A large bamboo, apparently restricted to Malacca and the adjacent islands. Col. Munro gives also Tenasserim as a locality for it, but in this he is in error. The habit is so much that of *Gig. maxima* that I would have unhesitatingly brought it in its neighbourhood, had not Col. Munro ascribed a "perigyn" to its fruit.

N. B.—DENDRO. FLAGELLIFER, *Munro*, from Malacca, is unknown to me, and the description not complete enough for identification. It seems to agree so far with *Bamb. aspera*, except in the large leaves.

GENUS SCHIZOSTACHYUM, N. E.

** Spikelets in nodding heads terminating the leafy branchlets. All florets sessile, except the uppermost sterile one.*

Low halms about as thick as a goose-quill; shoot-sheaths glabrous, hispid at the auricled mouth ... ... *Sch. chilianthum.*

20 to 25 feet high; halms very hollow and as thick as an arm; shoot-sheaths appressedly dark brown bristly, sparingly bearded at the hardly auricled mouth ... ... *Sch. elegantissimum.*

*** Spikelets clustered, the clusters in spikes. Only the rudimentary floret, or also the one or other of the hermaphrodite florets, pedicelled.*

† Stigmas white.

○ Imperfect blade of shoot-sheaths erect; ventricose inflated.

Halms glabrous; shoot-sheaths appressedly dark brown bristly; the auricles very large and long-fringed; leaf-sheaths at the mouth fringed with 6 to 10 lin. long hairs ... *Sch. Zollingeri.*

Halms pruinose or powdery, the lateral branchings remarkably short and slender; shoot-sheaths exactly as in the preceding, but the auricles very small and short-fringed; leaf-sheaths at the mouth fringed with 4 to 6 lin. long hairs ... ... *Sch. brachycladum.*

○○ Imperfect blade of shoot-sheaths flat and leafy, reflexed or spreading.

Shoot-sheaths covered with spreading tawny bristles, white-fringed at the produced mouth; leaf-sheaths at the mouth fringed with 3 to 4 lin. long hairs; spikelets ½ in. long *Sch. irratun.*

†† Stigmas purple.

Halms glabrous; shoot-sheaths appressed white bristly, hispid-ciliate on the produced mouth; spikelets ½ in. long ... ... *Sch. Blumei.*

Halms smooth and glossy; shoot-sheaths roughish, sparingly and minutely appressed white bristly, bristly fringed at the auricled mouth; spikelets an inch long... ... *Sch. longispiculatum.*

Flowers unknown, hence the true position doubtful.

Halms smooth; shoot-sheaths appressed black-brown bristly, smooth on the linear-produced mouth; the imperfect blade erect ... *Sch. serpentinum.*

Halms glabrous; shoot-sheaths appressed black—brown bristly, nude at the intensely green, hardly prominent mouth; the imperfect blade spreading or reflexed ... *Sch. Hasskarlianum.*

1.—SCHIZO. CHILIANTHUM.

(*Chloothamnus chilianthus,* Buse; *Melocana gracilis,* Kz.)

A small shrubby bamboo only 6 to 8 feet high, the halms of the thickness of a goose-quill or somewhat thicker, smooth and glossy; shoot-sheaths glabrous, hispid at the auricled mouth; leaves small; flower-heads nodding, long-peduncled; outer paleas glabrous; lodicules ciliate; anthers greenish; stigmas purple.

An elegant small species apparently not unfrequent in the forests of Sumatra and Singapore. The Malay name of it is booloo akkar (Palembang).

2.—SCHIZO. ELEGANTISSIMUM,

(*Bambusa elegantissima,* Hassk.)

A large shrubby species of 20 to 25 feet height and short live (only 3 years); the halms very hollow and weak, half-scandent at the extremities, green, as thick as an arm; shoot-sheaths appressed dark brown bristly, at the mouth hardly auricled and bearded with a few long hairs; paleas rough.

Growing gregariously in the hill-forests between the Tiloo and Malabar mountains in the Preanger regentships, Java, at 4,000 feet elevation; also in Bandong, in the primeval forests of Pekalongan, at 3,000 to 6,000 feet elevation.

It is called awie ul-ul (Sund.), bamboo eh-eh or bamboo oh-oh, pronounced, however, in a way as only a Javanese, with a huge tobacco-ball in his mouth, can do.

3.—SCHIZO. ZOLLINGERI, Kurz.

Arboreous, 25 to 35 feet high, the halms hollow, up to 2 in. in diameter, glabrous ; shoot-sheaths appressedly dark—brown bristly, at the mouth furnished with very large, long-fringed auricles; the imperfect blade ventricose inflated, erect; leaf-sheaths at the mouth long fringed (6 to 11 lin.) ; spikelets 3 to 4 lin. long, in interruptedly spiked clusters ; *outer paleas with smooth* edges and blunt ; lodicules none ; anthers greenish ; stigmas white.

Frequent along the banks *of creeks, etc., especially in the* hilly parts of Java; also generally cultivated in villages. The vernacular names for it are bamboo seereet kooda, bamboo *goleh-ah* and bamboo *tyang-kootrook* in Malay; also bamboo barekbek. (Sunda). The Javanese distinguish a small variety, bamb. seereet kooda ketyil, and a larger one, b. s. k. besár. The distinction is of an arbitrary nature.

4.—SCHIZO. BRACHYCLADUM, Kurz.

Arboreous, 30 to 40 feet high; the halms very hollow, pruinose or whitish powdered, as thick as an arm; shoot-sheaths very like *those of the preceding species*, but larger and the auricles very small and short-fringed ; leaf-sheaths at the mouth rather long (4 to 6 lin.) fringed ; spikelets 4 to 6 lin. long, clustered, the clusters *forming interrupted spikes ; outer paleas ciliate on the* edges ; lodicules 3, ciliate ; anthers purple, turning yellowish with black margins ; stigmas white.

This bamboo must be reckoned amongst *the rarer ones on* Java, but seems to be more frequent on the islands east of Java and on the Moluccos. It is very easily recognised in *having all the branchlets* unproportionally short and slender, giving it a peculiar habit, by which it is recognisable from a distance of several miles. It is called bamboo booloo by the Malays, and they distinguish two very remarkable varieties of it, *viz.* :—

Var. 1.—Bamboo booloo hedyoo (or idyoo), the green one, which has green halms delicately pruinose all over.

Var. 2.—Bamboo booloo konneng, also bamboo gadeeng, the yellow one, a fine variety with beautifully yellow halms covered with a white powder. The colour of these halms does not fade in drying, as it does in other species, and therefore this kind is much esteemed.

5.—SCHIZO. IRRATUN, Steud.
(*Melocana Blumei,* Kurz, *not of N. E.*)

Arboreous, 20 to 30 feet high; the halms about an inch thick, rarely thicker, hollow, covered with the dried up shoot-sheaths; the latter covered with tawny spreading bristles, white-fringed on the produced mouth and on the shortened ligule; the imperfect blade flat, reflexed or spreading; leaf-sheaths rather long (3 to 4 lin.), fringed at the mouth; spikelets $\frac{1}{2}$ in. long, clustered, the clusters in interrupted spikes; outer paleas minutely ciliate at the apex; lodicules 3, large, nude, or minutely ciliate on the tip; anthers yellowish green; stigmas white.

A bamboo much spread over Java, Sumatra, Balie and the Moluccos, and no doubt occurring also on the other islands of the Indian Archipelago. It delights, like its congeners, in the banks of creeks, etc. Bamboo tamyang is the usual Malay name for it, but it goes under many other names, such as bulu tuy (Balie); tabatico tuy or tuy tuy (Ternate); fuluck (Banda); utte lauit (Ambon); tinat (Hooamohel, Moluccos); bamboo Kasal (Sumatra); awie bong-konol (Sunda).

The Malays distinguish again a larger kind (bamb. tamyang besár), and a smaller one (bamb. tamyang ketyil); besides these, a third variety occurs, which is remarkable for the great percentage of silica contained in the wood of its halms. Owing to this richness in silica the halms emit sparks when cut with the parang (large wood-cutting knives); hence the Malay name bamb. tamyang sonoh.

6.—SCHIZO. BLUMEI, N. E.
(*Melocana tenuispiculata,* Kurz, *in the Bot. Garden, Java.*)

Arboreous, up to 30 feet high; the halms hollow, fragile, glabrous; shoot-sheaths appressedly white-bristly, hispid-ciliate

on the produced mouth and on the shortened *ligule; the* imperfect blade leafy, erect; leaf-sheaths shortly white-ciliate at the mouth, soon turning naked; spikelets ½ *inch long, very thin* and stiff, in spiked interrupted clusters; paleas smooth on the edges; lodicules none; anthers green to yellowish green; stigmas purple.

A pretty common bamboo of Java, which, however, I myself met only rarely along torrents and rivulets in the Buitenzorg Residency at 3,000 feet elevation. It is called bamboo *irrattun* in Malay, but often confounded by inexperienced Javanese with the bamboo *tamyang besár.*

7.—SCHIZO. LONGISPICULATUM, Kurz.

A large dense shrub, 12 to 20 ft. high, especially characteristic on account of the large leaves and the very long slender shoots which form large depending arches, the halms hardly thicker than a finger, smooth and glossy, often half-scandent at their extremities; shoot-sheaths roughish, glaucous-green, sparingly beset with minute whitish appressed bristles, bristly fringed at the auricled mouth; the imperfect blade erect or spreading, leafy; spikelets an inch long, in interruptedly spiked clusters; outer paleas smooth on the edges; lodicules none; anthers 2-cleft at the apex, yellowish green; stigmas purple.

Seems to be rather rare in Java, where it grows in Bantam and in the province of Buitenzorg. It is called bamboo mayang, mal.

8.—SCHIZO. SERPENTINUM, Kurz.

A shrubby bamboo, habitually very similar to the preceding and of the same size and foliage, also similarly emitting those curious long shoots from 30 to 36 feet long; the halms 1-1¼ in. thick, strong, smooth; shoot-sheaths appressed black-brown bristly, smooth on the linear-produced mouth; the imperfect blade leafy, erect; leaf-sheaths appressed dark-brown bristly; the ligule much produced; flowers, etc., unknown.

Frequent enough along the base of the Java hills at very low elevations, especially in Buitenzorg and in Bantam. It is called bamboo ooler (serpent-bamboo), and in Buitenzorg it

goes under name of bamboo kriesik. It resembles indeed very much the preceding species, but is entirely distinct in its sheaths.

9.—Schizo.? Hasskarlianum, Kurz.

(*Beesha Fax*, Hassk., *not of others*).

A dense shrubby bamboo 15 to 20 feet high; the halms hardly 1-1½ in. thick, glabrous, hollow; shoot-sheaths covered with appressed black-brown bristles, nude at the intensely green, hardly prominent mouth; the imperfect blade leafy, spreading or reflexed; leaf-sheaths appressed dark-brown bristly, naked at the auricled mouth, and at the ligule; flowers, etc., unknown.

Occurs along the base of the volcanoes of Java, at elevations between 2,000 and 3,000 feet, also on Sumatra in Padang. It is called bamboo lengka talie, which is a name given also to *Gigant. nigro-ciliata.*

Dr. Hasskarl describes the flowers supposed to be of this species, but I doubt whether they really belong to this plant, as the description of them agrees much more with those of *Schizo. Blumei.* On the other hand, Mr. Teysmann procured me flowers as belonging to this species, which would remove the plant to *Gigantochloa.* It is a species distinct from all others known to me, but its proper position must for the present remain an open question.

Genus DINOCHLOA, Buse.

1.—Din. Tjangkorreh, Buse.

This is a very distinct looking bamboo, at once recognized by being a lofty climber ascending into the highest forest-trees, and depending from them in gigantic festoons. It is very common in the hilly parts of Java and other islands at 3,000 to 4,000 feet elevation, but flowers only rarely. Tjangkorreh is the name by which it is generally known.

The above is a revision of those bamboos of the Malayan countries and islands which have become sufficiently known to serve practical purposes. There remains a small number of doubtful forms which I pass over. The bamboos of the Philippine

islands have also been omitted from the above revision on account of the great obscurity in which most of the species are involved. Australia, too, possesses bamboos on the northern coast, but specimens have never been collected. The only bamboo growing in Polynesia, is *Schizostachyum glaucifolium*, Munro., but this region is too remote from the Indian centre with which a forester in India has chiefly to scope, as to make it necessary to do more than simply allude to the fact.

According to the shape and indument of the shoot-sheaths, and their appendages, the various species may safely be recognised. For this purpose serve the shoots in a somewhat developed state when they are called seeroong by the Malays. Practically it would have been advantageous to give coloured pictures of the sheaths, but their number is too large, and the execution of coloured plates too expensive in India as to allow of their publication. They may be classed in the following way :—

A.—The imperfect blade distinctly separated from the sheath, and therefore more or less deciduous.

* Imperfect blade flat, more or less rounded at the narrowed base.

† *The same erect, or erect spreading.*

Bambusa Rumphiana.—Shoot-sheaths spreadingly bristly, the bristles purple and white; imperfect blade membranous, purplish green.

Bambusa vulgaris.—Shoot-sheaths appressed bristly; the bristles brownish black; the auricles fringed; ligule entire; imperfect blade leathery, green.

Gigantochloa atter.—Shoot-sheaths densely covered with brownish black bristles; the ligule slightly ciliate; imperfect blade leathery, dark or blackish green.

†† *Imperfect blade reflexed, or horizontally spreading.*

○ Shoots, as thick as a thigh or an arm.

Gigantochloa Apus.—As preceding, but the halms roughish and whitish, and the imperfect blade reflexed; the auricles almost obsolete.

Gigantochloa nigro-ciliata.—Also very near to *Gig. atter*, and difficult to distinguish from it, but the flowers entirely different.

Gigantochloa maxima.—Shoot-sheaths covered with reddish brown appressed bristles, smooth on the edges; the ligule fringed; imperfect blade leathery, dark green.

Bambusa aspera.—Shoot-sheaths covered with silvery grey appressed bristles, ciliate on the edges; the ligule long-fringed; imperfect blade dark green, leathery.

Gigantochloa robusta.—Shoot-sheaths almost villous from brownish black appressed and spreading bristles, obsoletely ciliate on the waved edges; the auricles and ligule long and stiff-fringed.

○ ○ Shoots about an inch thick, or somewhat thicker.

Schizostachyum irratun.—Shoot-sheaths covered with white spreading bristles.

Schizostachyum Blumei.—Shoot-sheaths covered with white appressed bristles.

Schizostachyum Hasskarlianum.—Shoot-sheaths covered with appressed brownish black bristles.

* * Imperfect blade ventricose-inflated, leathery, cordate or rounded at the base; sheaths appressed reddish brown bristly.

Schizostachyum brachycladum.—Auricles of the shoot-sheaths small, shortly fringed.

Schizostachyum Zollingeri.—Auricles of shoot-sheaths nearly an inch long, long-fringed.

* * * Imperfect blade linear or subulate.

Schizostachyum longispiculatum.—Shoot-sheaths rough, greyish green.

Schizostachyum chilianthum.—Shoot-sheaths smooth, glossy.

Dinochloa tjangkorreh.—Shoot-sheaths purple, pruinose; climber.

B.—The imperfect blade apparently continuous with the sheath and more or less equally decurrent on it, hence the blade more or less persistent.

Bambusa nana.—Shoots as thick as a finger, the shoot-sheaths glabrous, without or with very small fimbriate auricles.

Bambusa Blumeana.—Shoots as thick as an arm, or thicker, the sheaths densely covered with brownish black bristles, auricles long and stiff fringed.

Malays distinguish also with great dexterity the different kinds of bamboos simply by their halms, but I must confess, I could not succeed in doing the same in any way satisfactorily. If the bamboo is in flower, they say that they also often fail to recognise the species, probably because in that state great changes in colour take place.

In conclusion, I give here a tabular view of the halms of the various bamboo-species, their height, length, and thickness of the joints, diameter of the wood, in French measurement. I have added also the characters by which the Javanese distinguish the several kinds, and these characters I give entirely from oral communication of Javanese versed in bamboo matters.

On plates III. and IV, I have attempted to give graphical representations of these halms, (basal portions only,) and these should be consulted when using the following table :—

Tabular Statement of the various kinds of bamboo-halms and their differences according to the ideas of Javanese.

Plate.	Figure.	Native Name.	Height in meters.	Joints. Length in centimeters.	Joints. Diameter in centimeters.	Thickness of wood in millimeters.	Distinctive characters as given by Javanese.
III.	2	Bamboo andong bezár ...	30—42	40—48	13—15	20	Without prominent nodes, greyish green with greyish-yellowish stripes, covered with a thin appressed felt or almost glabrous.
III.	3	Bamboo andong ketyil ...	20—30	40—46	7½—8	25	Without prominent nodes, yellowish green with yellowish stripes, rough without being felty, when full-grown quite covered with lichens.
III.	1	Bamboo bitoong ...	30—40	32—40	12—13	30—38	The strongly prominent nodes fringed with strong rootlets, quite covered with grey felt, often growing somewhat crooked.
III.	9	Bamboo wooloong ...	30—34	36—48	11—12	26	Like bamboo andong, the halms narrowed and shortened at the base, turning almost glabrous.
III.	4	Bamboo atter besár ...	20—25	40—45	7—8	20	Without prominent nodes, greyish green, covered with lichens, below the nodes covered with fugaceous, appressed, brownish bristles.
III.	5	Bamboo atter ketyil ...	15—20	32—40	5½—6	19—20	As preceding, the halms somewhat rough, often beset with lichens.
III.	7 & 8	Bamboo apoos or b. talie ...	10—20	32—38	6½—7	15	As preceding, but almost leaden coloured and quite covered with the dried-up sheaths. Figure 8 represents bamboo-talie, which however is nothing but a younger stock.
III.	6	Bamboo ietam ...	14—20	36—40	6½—7	18	Like bamboo atter, but the halms black or blackish purple.
IV.	4	Bamboo tootool ...	12—15	30—32	5—5½	16	The nodes hardly prominent, dark-green, not glossy turning black-blotched with age.

IV.	1	Bamboo hower gulies ...	12—20	30—35	6½—7	15—18	Like the preceding, but always vividly green & glossy.
IV.	2	Bamboo hower konneng ...	10—12	24—25	5—6	23—24	As preceding, but uniformily and beautifully yellow and glossy, often may be seen also striped.
IV.	3	Bamboo hower sehah ...	10—12	25—30	5—6	16—17	As preceding, but all or nearly all the halms elegantly green and yellow striped, but in other respects not different.
III.	10	Bamboo dooree ...	10—20	30—35	8—10	22—24	Without prominent *nodes, yellowish green, glossy*; lateral branchlets all prickly.
IV.	5	Bamboo booloo hedyoo ...	10—15	56—60	6—7	6½—7	Without prominent nodes, vividly green, turning glossy, below the nodes whitish pruinous.
IV.	6	Bamboo booloo konneng ...	10—12	36—45	5—6½	8—9	Without prominent nodes, beautifully yellow, quite powdery from minute fugaceous hairs.
—	—	Bamboo tamyang besár ...	10—12	56—60	2½—3	4	Without prominent nodes, grey-green, sparingly beset with minute fugaceous bristles.
—	—	Bamboo tamyang ketyil ...	7—11	62—65	2½—3	3¼—3½	As preceding, only differing in height.
IV.	9	Bamboo tamyang sonoh ...	10—12	65—70	2½—3	2½	As preceding, but possesses the longest joints amongst Javanese bamboos ; the halms are very firm and to the touch very rough on account of their richness in silica.
—	—	Bamboo irattun ...	10—11	45—52	2—2½	5	Without prominent nodes, green, beset with whitish minute fugaceous bristles, which become more crowded and more conspicuous just below the nodes. Distinguished chiefly by its seeroongs.
IV.	7	Bamboo goleh-ah ...	8—10	35—40	4—4½	4½—5	Without prominent nodes, green, whitish pruinose below the nodes.
—	—	Bamboo kooda ...	10—12	48—40	2½—3¼	3¼	As preceding, but beset with minute white bristles.
—	—	Bamboo lengka talie ...	5—8	35—36	2½—4	7½	Nodes not prominent, grey-green, below the nodes appressed bristly from brownish fugaceous bristles.
—	—	Bamboo ooler or kriessik ...	6—8	30—36	2½—3	4½	Nodes very little prominent, green, smooth, grooved at the insertion of the lateral branchings.
—	—	Bamboo mayang ...	4—7	28—33	2¼—2¾	3¼	The nodes bordered with a prominent ring; halms yellowish green, glossy, whitish pruinose below the nodes.

Tabular Statement of the various kinds of bamboo-halms and their differences according to the ideas of Javanese.—(Concld.)

Plate.	Figure.	Native Name.	Height in meters.	JOINTS. Length in centimeters.	JOINTS. Diameter in centimeters.	Thickness of wood in millimeters.	Distinctive characters as given by Javanese.
IV.	7 bis.	Bamboo ul-ul ...	10—15	71—50	3—4½	2—2½	Nodes not prominent, green, smooth, has the thinnest wood-substance.
IV.	8	Bamboo tjina aloos ...	2—3½	32—35	1½—2	4	Halms green or yellowish, glossy; leaves white beneath.
IV.	14	Booloo akkar ...	2—3	22—24	0·5—0·7	2¼	Nodes not prominent, greenish yellow, glossy; small bamboo.
—	—	Leleba dyahat ...	2—3	36—45	1½—2	3½	Halms yellowish green or yellowish, smooth.
IV.	13	Leleba pooteeh ...	2—3	40—56	1¼—1½	2½	Pale green, smooth, turning white in drying.
IV.	10—11	Leleba soorat ...	3—5	46—52	2½—3	3	Halms green, striped pale yellow or rose, or in both colours.
—	—	Leleba tootool ...	3—5	46—50	2½—3	3	As preceding, but instead of being striped the halms are blotched in the same colours.
IV.	12	Leleba ietam ...	3—5	42—50	2½—3	3¼—3½	Halms blackish green, beset with fugaceous minute bristles, soon turning smooth.
—	—	Tyangkorreh ...	20—27	22—32	1—2	6—7	Climber, the halms somewhat zigzag.

N.B.—An apology is necessary with regard to the measurements being partly French, partly English, and also with regard to the spelling of the vernacular names. My revision of Indian Bamboo was written some 15 years ago, while I was in Java, and with other MSS. and drawings was sent by the Dutch Government to Prof. Miquel, Director of the Imperial Museum at Leyden, where they remained all the time. It was only after the death of this botanist that I succeeded, through the kindness and courtesy of Prof. Suringar, Miquels' successor, to recover my manuscripts, from which a great portion of the material, used in this practical paper, has been taken.

Alphabetical List of the vernacular names of the bamboos of the Malayan Islands.

Ampel jav = Bambusa vulgaris.
Arcuning (hauer konneng) = Bambusa vulgaris, var.
Aule (in Hitoe) = Bambusa Rumphiana.
Aur gadieng = Bambusa vulgaris, var.
Awie, sund = Bamboo generally.
— bongkonol, sund = Schizostachyum iratten.
— bunar, sund = Schizostachyum Hasskarlianum.
— buluh muntie, sund = ?
— gambong, sund = Schizostachyum Zollingeri ? ?
— gambong, sund = ?
— haur tutul, sund = Bambusa vulgaris, var.
— hiedung, sund = Gigantochloa atter.
— Leah, sund = Gigantochloa maxima ??
— mayan, sund = Gigantochloa atter ? ?
— sarengkol, sund = ?
— tela, sund = Schizo. Hasskarlianum.
— terelong, sund = ?

Bamboo, mal. = Bamboo generally.
— ah ah, sund = Schizo. elegantissimum.
— ampel, mal. = Bamb. vulgaris.
— andar, sund = Dendrocalamus strictus.
— andong besár, mal. = Gig. maxima.
— andong kekés, mal. = Gig. maxima.
— andong ketjil, mal. = Gig. maxima.
— apus, mal = Gig. apus.
— atter besár, mal. = Gig. atter.
— atter ietam, mal. = Gig. atter, var.
— atter ketjil, mal. = Gig. atter.
— aur goelies, sund = Bamb. vulgaris.
— aur konneng, sund = Bamb. vulgaris.
— aur seh-áh, sund = Bamb. vulgaris.
— aur tjutjuk, sund = Bamb. Blumeana.
— barekbek, mal. = Schizo. zollingeri.
— betung, mal. = Gig. aspera.
— bitung, sund = Gig. aspera.
— buluh, mal. = Schizo. brachycladum.
— buluh idjuh, mal. = Schizo. brachycladum.
— buluh konneng sund. or buluh kunieng, mal. = Schizo. brachycladum, var.
— djawa, mal. = Gig. maxima.
— durie, mal. = Bamb. Blumeana.
Bamboo ch-ch, sund = Schizo. elegantissimum.
— el-el, sund = Schizo. elegantissimum.
— gadieng, mal. = Schizo. brachycladum.
— gedeh, sund = Gig. maxima
— goleh-áh = Schizo. Zollingeri.
— gombong, mal. = ?
— hauer hedjoh (Jasinga) = Bamb. vulgaris.
— hauer goelies, sund = Bamb. vulgaris.
— hauer konneng, sund = Bamb. vulgaris.
— hauer seh-áh, sund = Bamb. vulgaris.
— hauer tjina (Jasinga) = Bamb. nana.
— hauer tjutjuk = Bamb. Blumeana.
— hauer tutul (Jasinga) = Bamb. vulgaris.
— hitam = Gig. atter, var.
— ietam, mal. = Gig. atter, var.
— irrattoen = Schizo. Blumei.
— kasab (Sumatr.) = Schizo. iratten.
— konneng = Schizo. brachycladum, also Bamb. vulgaris, var.
— kuda, mal. = Schizo. Zollingeri.
— kudu, mal. = Bamb. vulgaris.
— kriessik, mal. = Schizo. Hasskarlianum and also Schizo. serpentinum.
— lengka, mal = Dendro. strictus.
— lengka talie, mal = Schizo. Hasskarlianum.
— mayang, mal. = Schizo Blumei.
— minjak, mal. = Bamb. vulgaris.
— nanap, jav. = Bamb. corniculata.
— runieng, mal. = Bambusacea No. 2, Büse.
— sieriet kuda besár, mal. = Schizo. Zollingeri.
— sieriet kuda ketyil, mal. = Schizo. Zollingeri.
— surat (Jasinga) = Gig. maxima.
— talie, mal. = Gig. apus.
— tamjang besár, mal. = Schizo iratten.
— tamjang ketyil, mal. = Schizo. iratten.
— tamjang sonoh = Schizo. iratten.
— taman, mal. = Gig. atter.
— tjangkuttuk, mal. = Schizo. Zollingeri.
— sina, mal. = All small bamboos introduced from China and Japan.
— tjina alus, mal. = Bamb. nana.
— tutul, mal. = Bamb vulgaris.

Bamboo ueer, mal. Schizo. serpentinum.
—— wulung = Gig. robusta
Bitung, mal. = Gig. nigrociliata.
Bulo, Makass = Bamb. vulgaris.
Bulu, jav. = bamboo generally.
—— akkar (Palemb.) = Schizo. chilianthum.
—— badurie, mal. Bamb. Blumeana.
—— carissa = Bamb. Rumphiana.
—— gadieng, mal. *Bamb. vulgaris and also* Schizo. brachycladum.
—— gantang, mal. Gig. maxima.
—— jawa, mal. = Gig. atter.
—— kasal (Tum.) Schizo. iratten.
—— key (Banda). Bamb. vulgaris.
—— nitu, amb. = Bamb. Rumphiana.
—— potong, mal. Gig. aspera.
—— samet, mal. = Gig. maxima.
—— serie (Banda) Bamb. vulgaris.
—— seru, mal. = Melocana humilis, *Roep.*
—— swangie (Banda) = Gig. aspera.
—— swangie. mal. Bamb. vulgaris.
—— tombor (Banda) = Bamb. vulgaris.
—— totoan, Makass, = Gig. atter.
—— tuy, mal (Balie) = Schizo. iratten?
—— wanie, mal. = Gig. aspera.
—— wanie besr. mal. = Gig. maxima.

Domar (Leytimor) Bamb. vulgaris.
Doma (Amb.) = Bamb. vulgaris.
—— haboeca (Amb.) = Bamb. vulgaris.
Domal (Amb.) = Bamb. vulgaris.
Domulo (Amb.) = Bamb. vulgaris.

Fuluk (Banda) = ? Schizo. iratten.

Haur or hauer = Bamb. vulgaris.
—— heedjoh = Bamb. vulgaris.
—— goelies = Bamb. vulgaris.
—— konneng = Bamb. vulgaris.
—— seh-ah = Bamb. vulgaris.
—— tjina = Bamb. nana.
—— tjutjuk = Bamb. Blumeana.

Leleba Amb. = Bamb. Rumphiana.
—— djahat, mal Bamb. Rumphiana.
—— ietam, mal. Bamb. Rumphiana.
—— popo, mal Bamb. Rumphiana.
—— putieh, mal. Bamb. Rumphiana.
—— tutul, mal. Bamb. Rumphiana.
—— utan, mal. Bamb. Rumphiana.
Leleba (Ternate) = Bamb. Rumphiana.
Louleba (Ternate) Bamb. Rumphiana.
Louw (Ternate) = Melocana humilis, *Roep.*

Potong, mal. = Gig. aspera.

Samane mal. (Amb.) = All Larboreous bamboo.
Sammat mal. (Amb.) = All Larboreous bamboo.
Suelen (Banda) = Melocana humilis, *Roep.*

Tabat (Hœamohel) Bamb. Rumphiana.
Tabatico (Ternate) Diverse kinds of bamboo.
—— ake, (Ternate) = Gig. aspera.
—— java (Ternate) = Gig. atter.
—— nanie, (Ternate) = Bamb. vulgaris.
—— sammat (Ternate) = Gig. maxima.
—— tuy (Ternate) = ? Schizo. iratten.
Tallam, Makass = Melocana humilis, *Roep.*
Tamalla (Balie) = Melocana humilis, *Roep.*
Tapile (Hœamohel) = Bamb. Rumphiana.
Teba-teba (Amb. Ternate) = Bamb. Blumeana.
Telin, amb. = Gig. atter.
—— bahulu, amb. Gig. aspera.
Terin, amb. = Gig. atter.
—— hahuru, amb. Gig. aspera.
—— maysele, amb. Gig. maxima.
Tjangkorreh. sund. Dinochloa Tjangkorreh.
—— di-uk, sund Leptaspis urceolata.
Tihing ampel (Balie) = Bamb. vulgaris.
Tilapong (Balie) Gig. atter.
Tinat (Hœamohel) ? Schizo. iratten.
Tuy-tuy (Ternate) ? Schizo. iratten.

Utte, amb. = bamboo general.
—— aul or aule (Hitola) = Bamb. Rumphiana.
—— aul boppo, amb. = Bamb. Rumphiana.
—— aul mette amb. = Bamb. Rumphiana.
—— aul tuni, amb. Bamb. Rumphiana.
—— aux (Leytimor) = Bamb. Rumphiana.
—— lauit, amb. = Bamb. Rumphiana.
—— onitu, amb. = Bamb. Rumphiana.
—— wanie, amb. = Gig. aspera.
—— wannat (Hœamohel) = Melocana humilis, *Roep.*

Waan semane (Hœamohel) = Bamb. vulgaris.
Wanake (Lahœa) Bamb. Blumeana.
Wannat, amb. = Melocana humilis, *Roep.*
Wulu, = Bamboo generally.

EXPLANATION OF THE PLATES.

Plate I.—Fig. 1, shoots (rebongs) of bamboo andong, much reduced in size; fig. 2, a portion of a bamboo-halm screw-like twisted; fig. 3, a portion of a bamboo-halm with inflated joints (natural size); fig. 4, normal spikelet of leleba (*Bamb. Rumphiana*), enlarged; fig. 5, a proliferous one of the preceding, nat. size; fig. 6, spikelet of bamboo dooree, much elongated variety, nat. size; fig. 7, cluster of spikelets of *Schizo. longispiculatum*, nat. size; fig. 8, a pair of spikelets of preceding, shewing the sterile pedicelli, nat. size; fig. 9, a cluster of spikelets of bamboo andong besár, shewing some of the spikelets grown out into floriferous branchlets terminated by the sexual flowers of the original spikelet, nat. size; fig. 10, a similar cluster of spikelets of bamboo atter; ♂ male flower, ☿ hermaphrodite ones, nat. size.

Plate II.—Figs. 1 to 12, exhibiting the germination of *Schizo. chilianthum;* fig. 1, caryopse as it falls from the plant, retaining the paleas and the sterile terminal floret; fig. 2, id., the paleas removed, shewing the persistent lodicules; fig. 3, id., longitudinal section; fig. 4, the seed seen from the side; fig. 5, id., seen from the front; fig. 6, germination on the 4th day; fig. 7, further development on the 5th day; fig. 8, id., on the 6th day, *b*, section of it on a smaller scale; fig. 9, id., on the 9th day, *a*, from the side, *b*, from the front; figs. 10 to 12, stages of the 11th, 15th and 35th day respectively. All figures except 11 and 12 more or less magnified. Fig. 13, a flowering and fruiting portion of a panicle of *Pseudostachyum compactiflorum*, nat. size; fig. 14, fruit of bamboo dooree (*Bamb. Blumeana*), *a*, nat. size; *b*, magnified; fig. 15, fruit of bamboo bitoong (*Bam. aspera*), *a*, nat. size; *b*, magnified; fig. 16, fruit of bamboo lengka (*Gigantochloa nigrociliata*) *a-b*, both nat. size; fig. 17, fruits of the male bamboo (*Dendrocalamus strictus*), *a-b*, both nat. size, *c*, magnified.

Plate III.—*Diverse bamboo-halms.*—Fig. 1, bamboo bitoong (*Bamb. aspera*); fig. 2, bamboo andong besár (*Gigantochloa maxima*); fig. 3, bamboo andong ketyil (*Gig. maxima, var.*); fig. 4, bamboo atter besár (*Gigantochloa atter*); fig. 5, bamboo atter ketyil (*Gig. atter var.*); fig. 6, bamboo ietam (*Gig. atter, var.*); fig. 7, bamboo apoos (*Gigantochloa apus*); fig. 8, bamboo talie (*Gig. apus*); fig. 9, bamboo wooloong (*Gigantochloa robusta*);

fig. 10, bamboo hower tyootyook or dooree (*Bamb. Blumeana*).

PLATE IV.—*Diverse bamboo-halms*, continued.—Fig. 1, bamboo hower gulies (*Bambusa vulgaris, var. viridis*); fig. 2, bamboo hower konneng (*Bamb. vulgaris, var. lutea*); fig. 3, bamboo hower seh-ah (*Bamb. vulgaris, var. striata*); fig. 4, bamboo tootool (*Bamb. vulgaris, var.*); fig. 5, bamboo booloo hedyooh (*Schizostachyum brachycladum, var. viride*); fig. 6, bamboo booloo konneng (*Schizo. brachycladum, var. luteum*); fig. 7, bamboo golehah (*Schizostachyum Zollingeri*); fig. 7*bis*. bamboo ul-ul (*Schizostachyum elegantissimum*); fig. 8, bamboo tjina aloos (*Bambusa nana*); fig. 9, bamboo tamyang sonoh (*Schizostachyum irraten, var.*); figs. 10-11, leleba soorat (*Bambusa Rumphiana, var. striata*); fig. 12, leleba ietam (*Bamb. Rumphiana, var. nigra*); fig. 13, leleba pooteeh (*Bamb. Rumphiana, var. alba*); fig. 14, booloo akkar (*Schizostachyum chilianthum*).

Notes on the Burmese varnish and some other articles of minor Forest produce in Pegu.

By D. Brandis.

I am not aware that the extraction of the black Burmese varnish has ever been fully described, and it may perhaps interest the readers of this Magazine to learn something more on the subject. The varnish tree, Melanorrhœa usitata, belongs to the order of Anacardiaceæ, which comprises the Mango, the Píár or Chirongi, (Buchanania latifolia) the Bhiláwa (Semecarpus Anacardium) and the varnish tree of Japan (Rhus vernicifera). It is found almost everywhere in the Eng Forest of Pegu and Tenasserim; and in the Tharawaddi district, it is particularly common in the lower part of the Eng belt, where the soil is better than further east near the foot of the Yomah. The tree does not attain the same size as the Eng, Engyin or Theya, and at this time of the year (December) it may be known at once by its darker foliage. The leaves resemble those of the Burmese *Semecarpus* (Chayben) they are ovate-lanceolate, pointed at both ends, and covered with soft short pubescence; they are narrowed into a short petiole, while the leaves of Eng (Dipterocarpus tüberculatus) are glabrous, much larger,

and have a broad cordate base. Those of Engyin (Pentacme Siamensis, Kurz) which have about the same size, and of Theya (Shorea obtusa) are also glabrous, of an oblong shape with rounded ends. While these trees are in leaf it is easy to distinguish them. A large proportion of the Thitsee trees in the vicinity of Tyemyouk are lopped, but we saw large numbers along the road which had not been touched, and this important industry might be increased to a large extent.

The process was described to me by a Shan who had settled at Tyemyouk 4 years ago, and had like many thousands of his countrymen emigrated from Upper Burma into British territory with his entire family. Near Myoung, 6 miles further north, Thitsee is collected by Burmans, also emigrants from Ava. Moungmyat, this is the name of the gentleman who taught us his art, is a native of Thoonzay, 5 marches east of Mandalay, on the Myitgne, a tributary stream of the Irrawaddy, which joins that river near the site of Ava, the former Capital of Burma. The province (Myo) of Thoonzay is situated in about 23° North Latitude. The country is mountainous, the higher hills being clothed with Pine Forest (probably Pinus Kasya) the wood of this pine, he said, was not used for building, as it was not durable, but torches were made of it. Teak is found on the lower hills and the forests are worked. There is also Eng Forest with Thitsee, from which much varnish is extracted, and a large number of other trees found in Pegu, such as Taukyan (Terminalia), Bambonay (Careya), but there is no Pynkadoe (Xylia dolabriformis,) Pymmah (Lagerstroemia Reginae) Myaukshaw (Blackwellia tomentosa), no Thingan (Hopea) or Kanyin (Dipterocarpus). Those who are acquainted with the Forests in India, will see at once that some of these trees are found in South India, though they are wanting in North and Central India. Of cultivated trees the Mango, Plantain, Custard-Apple, Jack fruit are common in that part of the Shan States, while the Cocoanut, the Borassus and Thittoben (Sandoricum), all purely tropical trees, are wanting.

But now to the extraction of varnish. The trees which have been tapped are at once known by triangular scars about 9 inches long and 5 inches broad, the apex pointing downwards.

On some trees we counted 40-50 of these scars, and some of them at a height of 30 feet. To work the higher scars the Shans use a most ingenious ladder which is permanently attached to the tree. It consists of a long upright bamboo with holes cut through at intervals of 2-3 ft. Through each hole are passed two flat bamboo sticks driven with their pointed ends into the bark. These form the spokes of the ladder and are about 12 inches long. The scars or notches to extract the varnish are made with a peculiarly shaped chisel about 15 inches long, the handle is of iron, of one piece with the chisel and about 9 inches long, the lower end thicker, hollow and closed with a bamboo plug. The chisel is wedge-shaped, about 6 inches long (the edge half an inch broad) and forms an obtuse angle with the handle. With this instrument two slanting slits, meeting at an acute angle are made upwards through the bark, and the triangular piece of bark between the two slits is thus slightly lifted up, but not removed. A short bamboo tube about 6 inches long, with a slanting mouth and a sharpened edge is then horizontally driven into the bark below the point where the two slits meet, and the black varnish which exudes from the inner bark near its contact with the wood runs down into the bamboo tube, which is emptied at the end of ten days, when it ceases to flow. A second cut is then made so as to shorten the triangular piece of bark which had been separated from the wood when the first cuts were made. A shorter triangular piece of bark remains, ending in an angle less acute than before, and the appearance of the scar is then as below.

The bamboo tube, which before was at *a*, is moved a little higher, (to *b*) and the edges of the original cut, (*c b* and *d b*) are cut afresh. The varnish then runs out for another 10 days after which the scar is abandoned. The trees vary in yield exceedingly, a crooked tree with scanty foliage which we examined, was said to yield a good outturn, while some of the largest trees were said to yield very little. We saw trees tapped which had a diameter of only 9 inches. Moungmyat informed us that one man could make and look after 1,200 scars, that he could do 200 in a day, so that the whole number occupied 6 days, which

left 4 days for rest. They only work in those parts of the forest, where the tree is abundant and the trees fit to tap stand close together. The tree yields nothing while it is leafless in the hot season, and the best season for working is from July to October. One man collects 40-50 viss, (146 to 182 lbs.) in one season, at Tyemyouk the viss sells for 12 annas and at Rangoon for one Rupee.

In the slack season these men are employed in making torches of the Eng tree woodoil, and I add a few particulars regarding the collection of this valuable article. Unlike the varnish the woodoil exudes not from the bark, but from the outer layers of wood, to a depth of about 2 inches. Neither the outer grey bark, nor the inner red bark, yield woodoil. The Eng tree belongs to a natural order of plants different from that of the varnish tree and the Kanyin tree which is of the same order, also exudes woodoil from the outer layers of wood. It will however be remembered that among conifers, which all belong to one natural order, some, such as the Larch and Pinus Pinaster, exude resin from the wood, while others, like the spruce, produce it in the bark. Deep semi-circular niches are cut into the wood, the first cut is about 4-6 inches deep and 12-18 inches wide, the bottom of the niche being slightly hollowed out, to receive the oil. It oozes out and collects at the bottom of the niche about 3 days after the cut has been made. The surface is then charred with fire, after which the oil runs for three days; this process is repeated four times, and at the end of 15 days the surface of the niche is cut afresh, the old charred wood being cut away and the niche enlarged. After the oil has run for three days, the surface is again charred, and the original process repeated. The Eng tree yields oil throughout the year, and one tree often yields oil from several niches at the same time. I saw a tree with 6 niches, two of which were yielding oil at the time. One man can make 2,000 to 3,000 torches in a year, and 100 torches require about 10 viss (36 lbs) of oil which is mixed with touch wood and neatly wrapped up in the leaves of palms or of the Tsathoaben, a species of Pandanus, so as to form cylinders about 20 inches long and 2 inches in diameter. They

are tied with thin strips of bamboo, generally Tinwa, (Shizostachyum pergracile). Elsewhere, *e. g.* in the Hlaine district, the leaves of the Zalooben (Licuala peltata) are used for this purpose. This is the information which was given me in the Eng Forest of Tyemyouk, and if it is correct, a man can collect about 700 to 1,000 lbs of woodoil in a year. These torches are sold at Rs. 3-8 or 4 a hundred near the Forests. The woodoil of the Kanyin tree is collected precisely in the same manner. One man can manage 30 to 40 oil yielding Kanyin trees; he goes round with a number of hollow bamboos or other vessels and one collecting gives him 3 to 4 viss. In Pegu the torches made of the Kanyin oil sell at the rate of 64 per rupee.

The collection of minor Forest produce in Burma, such as the Woodoil of the Eng and Kanyin trees, the leaves of the different trees which are used as covering leaves for the Burma cheroot, Bambouay, (Careya arborea) Thanat, (Cordia grandis)—and the most valuable of all the Mhayah ben, (also a species of *Cordia*) the manufacture of catechu, the collection of varnish, of the stems of Maranta dichotoma, of which the beautiful soft Thinbyu mats are made, of rattans, of the bark of several trees, especially of 3 species of Sterculia, for rope, and of an immense variety of other useful and necessary articles is as yet perfectly free in the Government Forests of Burma. Of many of these articles the supply is almost unlimited, but of some the supply has already become scarce, and early measures will have to be taken by the Forest Department to increase the supply and to prevent waste as far as practicable. Thus the leaves of the Mhaya tree are now imported into Rangoon from the Gamoong and other Forests of North Tharawaddi; they are dried by an old, but most ingenious process, a round shallow iron pan 18 inches diameter is heated over a fire, the leaves are placed on it 4 or 5 one on the other, and are ironed with a flat disk of basket work (kyattonk) covered with cotton cloth, and filled with stones, a wooden handle being in the middle. The leaves which are 12 to 15 inches long are sold by number, 10,000 leaves selling for 6 to 10 rupees at Wyne near the Forests; and for 15 to 20 rupees at Rangoon. They are most carefully packed in large baskets which are

either carried on men's shoulders or carted to the Meimakha river whence they go down in boats. I found the tree cultivated at Kwemma village near the Beeling river. Formerly Mhaya leaves were largely exported from the Hlaine Forests to Rangoon, but the destruction of the tree has been so great, that the supply from that district is exhausted. The export from Tharawaddi will probably have a similar end, for the trees are cut and lopped most recklessly to obtain the leaves; and many trees have died from this treatment. Another article which is becoming scarce is Catechu, and as the demand for this beautiful and most useful substance is apparently increasing rapidly in Europe and America, and as the price is rising, steps have already been taken to increase the supply, and it may be necessary to restrict the indiscriminate cutting of Catechu trees in British Burma. An article of universal use for rope manufacture is the bark of three species of Sterculia, Showbju (S. foetida) shownee (S. villosa) and showwah (*S. ornata*). The useful portion is the inner bark or liber, it is peeled off in the hot season, and trees of all ages and sizes are recklessly felled to obtain it. The bark of all 3 species is of the same value, but that of the Showbju is most difficult to peel off. At present 100 viss. of show sell for 10 rupees at Tsayjoua in the Minhla district, 20 years ago the price was about one-half of this. The varnish is another important produce, the demand for which is certain to increase, and a permanent supply of which must be secured. No difficulty need arise in this respect, if things are properly managed, for all that is required is, to include within the limits of the Reserves a sufficient area of Forest producing Catechu, Thitsee, Show, the Mhaya tree and other trees which furnish useful produce.

Camp Koon Beeling, December 1875.

Report on the collecting of seeds and plants of the India-rubber tree (Castilloa elastica) in the forests of the Isthmus of Darien.

By Robert Cross.*

The following is a detailed statement of my late journey to the Isthmus of Darien, where I have been recently engaged in making a collection of seeds and plants of *Castilloa elastica,* the tree which chiefly yields the India-rubber of commerce exported from the Republics of Central America, Mexico, New Granada, and Ecuador. In conformity with instructions received from Mr. Markham during the early part of this year, I left Southampton on the 2nd of May and reached Panama on the 26th of the same month.

I remained at Panama for fifteen days in order to gain all information regarding the size and yield of the rubber trees of the various districts. The tree is found growing from 1° south latitude to 20° degrees or more north of the Equator, but in such a wide expanse of country there are probably various varieties, most of which however may bear a close resemblance to each other, although some may be of more robust habit than the rest, and attain to a greater size. Experience has proved that such is the case with most families of wild plants when brought under cultivation. Of late years a good deal of India-rubber has been brought from the forests on the Pacific Coast, South of Panama, near to a scattered village called Darien. The Indians in this region have been rather hostile to the collectors, and the export has in consequence been much reduced. The greater portion of the interior of the Isthmus has been explored and the largest trees have been cut down. North of Panama, in the district of Chorera, there were once considerable numbers of trees, but these have been, to a great extent, demolished by the natives, who usually cut down the trees in order to tap or bleed them more easily. The replies to my inquiries respecting the size to which the India-rubber trees grow in the forests about the village of Darien

* This interesting report has been sent to us by Mr. Clement Markham, to whom we herewith tender our best thanks.—The Editor.

did not fully satisfy me. Therefore I proposed to examine the woods on the confines of the larger tributaries of the river Chagres, where trees of large dimensions were formerly met with. The period of my arrival at Panama happened to be the wet season of the year, which in the region of swamp and forest is considered particularly unhealthy. Indeed on this account Captain Mallet, H. M.'s Consul at Panama, thought I should await the return of the dry season. I afterwards found that his remarks concerning the climate were quite correct, and except for the experiences I had previously obtained while travelling in the hot valleys in the interior of New Granada, I would in all likelihood have been prostrated with fever. But the seeds ripened during the rainy season, so that it was important to examine the forests for seed-bearing trees at this period.

Journey to the forests.—On the 9th of June I left Panama by the railway and stopped at a place called Gatun, about 8 miles from Colon. Leaving the railway tract, I crossed the Chagres and took up my quarters in the village of Gatun which is built on the northern bank of the river. The town is formed of two streets 150 yards long with rows of houses on each side thatched with palm leaves. In most instances the walls of these houses are patched up in a miserable manner. Alligators swarm in the river, and any one who might attempt to bathe in it would soon be devoured. Water is obtained for domestic purposes from barrels sunk in the ground in low situations; they are provided with lids and must be kept constantly covered to prevent toads and snakes from entering. The village contains about 300 inhabitants, the greater number of whom are of Negro extraction. The situation is so low that during high floods the streets are inundated, and people ply about from house to house in canoes. On both sides of the river the country is swampy, although in great part clothed with forest. Penetrating into these woods I found the place swarmed with mosquitoes, frogs, and uncountable millions of ants, and the snakes, instead of getting out of the way, raised their heads in a position of defence, ready to strike at any one who approached. These swamp forests present a dis-

mal aspect and reminded me of the mangrove forests (*mang-lares*) which grow in the flat deposits of fetid mud that occur on the margin of the Gulf of Guayaquil, and other places along the Pacific Coast. The native with whom I was located at Gatun was a good fellow, but the greater number of the inhabitants were disobliging and uncivil. They were positively the worst class of people I have yet met with in any country. Everywhere the land, if cultivated, produces abundantly, but such is the indolence of these people that bananas, rice and mandiocas are raised in limited quantity scarcely indeed sufficient to maintain them. I found on inquiry that no India rubber trees existed in the swamp forests, and that to find them it would be necessary for me to ascend the river for some distance and then travel up to the dry land of the interior. The person with whom I lived collected India-rubber, and he had a hut in the heart of the forest, where the collectors often staid for the night. A few days after my arrival he proposed going to this place, and although the weather was unfavourable I resolved to accompany him, as I was anxious to become well acquainted with the *habitat* of the tree, and also to ascertain if any seeds were to be found. Leaving at early morn, in a canoe, we ascended the river Chagres for a number of miles and then entered a smaller river called *Vino tinto*, which rises from a large swamp in the interior. The water of this river was full of decayed vegetable matter, appearing as if vast quantities of the trunks and leaves of trees had been systematically ground up and mixed with it. On the banks, which were high, grew an astonishing rank growth of large trees and bamboos, and many of these had fallen into the water and lay partially submerged, thus forming serious obstacles for even the navigation of a canoe. Beyond the landing point a short distance of swamp land was travelled over, on which grew principally thickets of palm trees and bamboos. Then the way ascending led to drier land with some flat undulations, the greater portion of which had an elevation of about 50 feet above sea level. An India-rubber tree was first seen in this locality growing near to a little stream in a very moist situation. Saplings or young rubber plants were subsequently met during the rest of my

journey. After passing the flat land we ascended a ridge of low hills and undulating inequalities, which were clothed with the stateliest forest I have ever witnessed. Many of the trees, belonging to the order *Lauracea*, had straight smooth stems which rose often to a height of 150 feet without a branch, and a massive species of *Bombax*, called by the Indians *quipo*, grew mostly on the summits of the hills, and had frequently a clear trunk of 200 feet high with a flat crown of green foliage like an umbrella, giving to these hills a grandly imposing and majestic appearance. Palms of various species were tolerably abundant, and in places the undergrowth was composed of extensive thickets of a species of *Bromelia*, which had formidable prickly leaves ten feet in height. Both the trunks and branches of the trees were destitute of mosses (*Selaginellas*), although a robust species interwoven with *Adiantums* formed luxuriant clusters on the ground. A species of cacao (*Theobroma cacao*) grew wild on the hill sides and in the ravines. Its short slender trunks and branches were adorned with many fruits each of which enclose a number of cacao beans. However these, on ripening, are duly visited by monkeys, hundreds of which were jumping about and screaming among the tops of the trees. The rubber saplings always appeared to grow most freely on the banks of little cool clear streams, the roots often running down to the edge of the water. They abounded also in deep rich soil along the base of the hills, and in both deep and shallow ravines. Plants were likewise met with on the summits of the ridges and in fact in all localities where there was no swamp or marsh land. Some plants were observed growing among masses of volcanic rock, where there was not much soil, but plenty of decaying leaves and particles of *debris*. Prostrate trunks were observed on the way, some of which had attained to a great size. We reached the rubber hut rather late, having travelled two days journey in one. The hut was situated on an eminence between two ridges of hills. A stream of water flowed past the dwelling. It swarmed with incredible numbers of little fishes about the size of needles. A small portion of forest had been cut down and a little Indian corn and a few roots had been planted. The

trunks of some of the felled forest trees were five feet in diameter. Formerly a great many large rubber trees were found at this spot which had yielded to the collectors a rich harvest. Probably for this reason they called the place La Providencia. In the surrounding forest grew some young rubber trees, a few of which averaged from 50 to 70 feet in height. One of these bore a considerable number of unripe fruit. It was evident the fruit would take from ten to fifteen days to ripen.

Meanwhile I resolved to search for some young plants to experiment with. An Indian who was employed to take care of the hut and its stores lent me one of his sons, a lad about fifteen years of age. He came away with me completely naked and entering the forest we succeeded in collecting 40 good plants. Returning to Gatun I rested a few days, and made two more journeys without finding any quantity of seeds. But the fruit of the tree already alluded to was approaching maturity and it was necessary that these should be watched. Revisiting the place on the 18th of July I found the seeds had ripened. To facilitate the work of collection the tree was cut down and all the mature fruit was gathered. The fruit has a short stalk and springs from the axils of the leaves. It resembles in some measure a *Jargonelle* pear, but is shorter, and is diversified with rough scales. The crown is flat, and when ripe, assumes a beautiful scarlet colour, while all the rest of the fruit remains green. The seeds in size and appearance resemble coffee beans, and are immersed in an orange-coloured pulp. The soft pulpy matter was washed away and the seeds were put to dry. I was disappointed on observing that some of the seeds had already begun to germinate. This indeed was to be expected; for they have no hard covering and when ripe are nearly as easy to bruise as green peas. In fact it seems natural for these seeds enveloped in a soft juicy mass to begin to grow whenever the fruit falls to the ground or even sooner. I now resolved to go on to Gatun without delay, and dispatch the seeds as early as possible from Panama. In conformity with a previous arrangement a negro came on July 21st to the landing place of the Vino tinto River to take me down to Gatun. The canoe which I had brought up with me had been taken by a

native without permission; but he had left another in its place, which, although smaller, was still large enough to carry two persons if managed with prudence. The negro had got together various things which he was not expected to take and which with ourselves formed a full load for the canoe, even if managed with care. It had already rained lightly for several hours, but at the moment of embarking the rain came down in torrents, and if not baled out would soon have filled the canoe. I was in the prow of the canoe and the negro in the stern, steering and paddling as the case might require. The river was much swollen with driftwood and trunks of trees in every direction, and I several times warned the negro of these obstacles, but unlike the Indians, he had no patience for surmounting difficulties, or it may be the tempest put him in a reckless mood. From the first I expected we would have an accident and put off my boots and part of my clothing so as to be able to swim if anything happened. We had only gone a short distance when I observed a stout projecting trunk near the surface of the water a little in advance and directly in front of the canoe. I immediately told the negro of it, but received only a low grumbling sound in reply. In a few seconds after the canoe struck against the trunk.

The shock caused the prow to sweep round towards the river bank, but at the same moment a quantity of water rushed in at the stern. I saw it was now time to endeavour to make an escape and jumping into the water I pushed myself off from the canoe and with only two strokes of swimming was able to take hold of the bushes on the river bank. On looking round I saw the negro struggling in the water having a hold of the canoe and attempting to find a footing on some of the sunken trees. At length he managed to get to the river's edge very much exhausted. But the accident was entirely his own fault; for with a due amount of caution it would not have occurred. The canoe was baled out and we resumed our journey.

As I had now no great confidence in the abilities of the negro as a navigator, I took off all my clothes and sat in the canoe naked until I reached Gatun. In this state I could swim more easily if such another accident took place. During the

journey down the river it rained the whole time and I shivered from the cold, although the temperature must have been at least 75° Fahrenheit. On arriving at the village I put on dry clothing, drank a cup of hot coffee, and felt well afterwards.

The negro who slept for the night in a corner of the same apartment as I did, awoke me several times by sighing, talking to himself and moving about restlessly, so that mentally as well as physically he seemed to have suffered most.

During the succeeding days I had great difficulty in drying the seeds, as it rained almost continually, so that the atmosphere was saturated with moisture. The rain was often accompanied with cold winds which brought on much sickness among the inhabitants. The illnesses with which most were afflicted were fevers, dysentery and ulcers. Of these diseases about 80 per cent. of the population were suffering. The former, which is usually known by the name of "Chagres fever," is the worst and most debilitating in these parts. It is stated by some that dysentery is brought on by this kind of fever. The plague of ulcers, which was very common, was a new phase of disease to me, for although I had travelled in the hot pestiferous valleys of the interior of New Granada where the inhabitants are systematically devoured by *lepra* and cancerous diseases, I saw nowhere the same type of ulcers as here on the Isthmus. A native told me these were produced by the bite of a mosquito. It is apparent that the disease is confined to the swamp forest districts. A stout robust healthy boy on one occasion ferried me across the Chagres River. About three days afterwards I wanted him, but found that an ulcer had broken out on his ankle and was now three inches in diameter. The rapidity with which these ulcers increased was truly surprising. During my various journeys to and fro in the forest, I sometimes travelled barefoot and had a number of scratches and tears, but these shewed no disposition to become ulcers. On the contrary, they seemed to heal more quickly than in a cold climate. However I do not know how long this good fortune might have continued. At times I had occasional touches of cold ague, but without headache. Yet the food was dear and scarce, and the

habitations everywhere were of the most wretched description. Sometimes a snake escaped from the swamp behind the village and was seen to enter the patched up wall of some dwelling. Such an event caused a great stir among the inhabitants, a number of whom would surround the house in order to capture the reptile. These efforts were in general unsuccessful.

Dispatch of Seeds from Panama.—On the 27th of July I went on to Panama for the purpose of forwarding the seeds. From what I had already observed I had little confidence that they would succeed, as all oily seeds are well known to lose their germinating power very early. But it was best that there should be a trial, although I had all along fully resolved to take with me a collection of plants. On the 5th the seeds, amounting to upwards of 7,000, were kindly forwarded by Captain Mallet, H. M.'s Consul at Panama, a gentleman from whom I invariably received all necessary advice and assistance. With the change of residence to Panama it seemed to me as if I had really entered a kind of paradise. The difference was great from my previous location, where I had been living on a very limited supply of food in a low-roofed damp hut, from the eaves of which the dropping of water hardly ever ceased, and where the whole scene was walled round by green mantling thickets of lofty forest trees, bathed daily by drenching rains.

Return to the forests for India-rubber plants.—As I have already remarked I fully purposed to bring home some plants with me, and I now made arrangements for accomplishing this object. On my return to Gatun the rains came on with increased violence, and the river was greatly swollen. Yet even with the unfavourable weather a collection of plants was got together from various localities around La Providencia. I was assisted by three natives one of whom was bitten on the leg by a bat when he was asleep. From this simple accident the man was laid up for four days. Although found growing in varied aspects the plants were not met with very plentifully. But in one locality upwards of 100 plants were found growing under a good-sized tree. The seeds had fallen on a bed of decaying leaves and germinated in

great numbers so thickly indeed that many of the plants had smothered each other. In all six hundred plants were collected, but a good number were bruised, while being carried through the forest, or during the journey to Gatun. A quantity of the milk of the tree was also secured. Mr. Matthew Gray, a member of one of the largest rubber-manufacturing firms in London, kindly made some remarks to me concerning the preparation of the article. I therefore endeavoured to prepare a specimen with some care. But I did not succeed with the operation as I intended, for I had very little room and the natives crowded about me too much, as they were curious to see how I did everything. The milk-like juice of the tree had thickened a good deal during the journey, so I spread it out on a piece of zinc exposed to the sun and put a boy to stir it about a little, when it soon became firm. It was then taken off the zinc and hung up to dry. Notwithstanding the rough method of preparation the sample seemed of fair quality. I next turned my attention to the plants and dressed them very carefully. These were young saplings cut down, and the tap roots which were often of great length were also much shortened. The roots were packed in three boxes with dry leaves, a process which facilitated transport but demanded an extraordinary amount of attention. Shortly after my first arrival I collected a few plants which, with some stout pieces of the stems of saplings cut into lengths, I planted to experiment with. The greater number prospered wonderfully, and some natives were surprised at the quickness of the result. I put the most advanced of these plants into a small box, and although some lost a few leaves yet I brought the best portion home alive. Thus I saved sufficient plants from this little collection for the formation of stock for the plantations in India.

Methods of collecting rubber practised by the natives on the Isthmus of Darien and other places.—One of the oldest rubber collectors of the district where the plants were procured assured me, that at first they sometimes met with a tree at which three or four axemen could go to work at once to cut down. Such a tree would probably be about 8 feet in diameter, 200 feet in height, and yield at least 150 pounds of India-rubber. In

general full-grown trees do not much exceed 160 to 180 feet, with a diameter of five feet, and a produce of 100 pounds of rubber. The bark of the trunk is thicker than that of most trees of the same dimensions. The wood is spongy and soft, and decays rapidly wherever injured. The slender branchlets that crown the trunk terminate with four or five large leaves alternately arranged and thickly covered with short brown hairs. Many of the leaves measure 14 inches in length and seven inches in breadth, and exceed in size those of any other tree of tropical America. According to the natives, the leaves fall off the trees *in January, after which they begin to flower.* In April the new leaves push, and attain their full size in May. But I was assured that young plants and saplings retained their leaves throughout the year. The milk-like juice of the tree, which, when congealed, forms India-rubber, is obtained by cutting out a groove or ring of bark around the base of the trunk. The milk exudes from the bark into the channel thus formed, and large leaves are *placed so as to receive it as it trickles down.* The tree is then felled, and rings or channels are cut out around the prostrate trunk, at about 12 or 14 inches apart. Beneath these leaves or vessels are placed into which the milk flows. The contents of all the vessels are afterwards put in a hole previously dug in the ground. The milk left in this way becomes curdled in about two weeks. In the Republic of Ecuador most collectors use the soft green stem of a climber—a species of *Ipomea*—which when bruised and stirred about in the milk congeals it in a few minutes. By this last process the milk takes up all the watery particles it may contain and the produce seemed to be of an inferior kind, possessing a strong peculiar smell, and continually sweating a black ink-like water. Soap is resorted to by some collectors, and also wood ashes which contain potash. Collins mentions *that alum is used in Brazil and salt in the East.* It seems to me that whatever method is adopted the rubber ought to be prepared *rapidly and to be perfectly dry and free from impurities.* Powerful presses might no doubt expel the moisture, but I should expect that the goodness of the article would by this operation be depreciated. My own opinion is that the quality of the milk-like rubber juice obtained from various

species of plants—some of which are climbers and shrubs while others become large trees—is at first exactly the same, and that the difference in value of various parcels is explained by a different mode of preparation. The collectors indeed always aim to keep it as wet as possible as it is bought by weight. At Nicaragua and some other places of Central America the trees are not usually felled. The practice is to cut winding channels in the bark leading to the base of the trunk, where the milk is collected. But I was informed by an intelligent person from that region that this operation is so rudely and carelessly performed that a tree invariably dies after it has been bled or tapped a second or third time. This would never take place if the thin filmy lining of the inner bark (*cambium*) which covers the wood was not bruised or injured.*

Not only do the natives cut through the *cambium*, but they also make large notches in the living wood of the tree, and these under no possible class of circumstances or conditions can ever be healed. In collecting the milk the *cambium* need not be hurt, as the vessels which contain it really occur in the middle of the bark. Such at least is the case with the Darien rubber tree. The employment of any simple implement so formed as to make a groove in the bark to about one-half its thickness, is all that is required. Such an operation would require to be directed by an intelligent, careful person, who thoroughly understood how much success depends on the proper performance of the work. In this way not one single tree in a thousand would be lost and the trees might, in my opinion, be operated on annually, instead of once in three years, which I have been informed is the practice at Nicaragua. Dr. Macdowell, a gentleman connected with the *Star and Herald* of Panama, whose practical and scientific articles would well compare with those of the best-conducted English journals, has repeatedly called attention to the reckless and destructive methods employed in collecting the vegetable products which grow spontaneously in the forests of Central and South America. However, too little notice has

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* Experience with the Ficus elasticahas raised serious suspicions with us, that the trees will die, if tapped repeatedly, whether the operation is performed carelessly or not.—THE EDITOR.

been taken of his observations either by the State or Municipal Governments. I have noticed during my travels that in the process of collecting the wild products of the forests there is often much wasted by the natives.

Climatic conditions of the India-rubber regions.—The temperature of the forests in the interior of the Isthmus ranged from 75° to 88° Fahrenheit. Frequently I have observed the thermometer standing at 80° at eleven o'clock at night, and the same on various occasions at one and two o'clock in the morning. When there occurred a shower of rain accompanied by a north wind the thermometer went down to 74° for one or two hours; but this was the lowest point to which it fell. I have not been able to ascertain to what altitude the tree grows as no high hills exist on the Isthmus, but I am pretty confident from observations made while travelling on the Pacific coast, that it ascends at most to an elevation of about 1,500 feet. At this height the lowest temperature experienced at any time throughout the year would be 62° or 60° Fahrenheit. As regards moisture, I happen to have lived and travelled in various rubber districts, where the rainfall varied considerably. On the Pacific coast, the tree grows near the Gulf of Guayquil on flat or gently sloping land, in deep deposits of a very sandy loam. The vegetation is moistened by humid fogs, but showers of rain very rarely occur. On the whole the atmosphere is unusually dry.

At Esmeraldas the soil is a heavy loam or clay. There is about five months of dry or summer weather and the remaining months are rainy.

In the neighbourhood of Buenaventura the tree is found dispersed over a broken and dislocated region of narrow ridges of nearly naked conglomerate with steep shelving ravines more than a 1,000 feet in depth. Where there is soil it is loam or a kind of clay, or made up of vast heaps of decomposing *debris.* The rains here are almost unceasing, day and night, throughout the year. This part of the coast, and on as far as the river San Juan, has been considered by intelligent travellers as the most unhealthy tract of country in the world.

The region proper of the Isthmus of Darien lying farther northward and including Portobello, Colon, Chagres, and Panama, is very wet, with an excessively damp atmosphere, although the weather is generally better, with some sunshine, during the months of January, February, March and April. The deposit of the low flat hills is more or less of a clay character, but along the banks of streams or rivers the deposit is mostly of rich but deep sandy loam.

Many of the localities bordering on the Magdalena possess deep beds of sand and loam resting on a stratum of yellow gravel. The climate is often parched and dry. Rain falls in May, June, July, and August.

It will thus be seen that this rubber-producing tree is subjected to a variety of climatic conditions which might have been expected from the wide extent of country over which the species extends. These circumstances appear to me to present a favourable prospect for its successful cultivation in India.

The Indians of the Isthmus of Darien and the Andes.—There were few Indians in the forests where I was engaged, but some families are still scattered along the banks of the Rio Trinidad. The remains of an independent tribe lived in a locality about six hours journey north of La Providencia. There were some large rubber trees at the place, and a collector, whom I knew, asked liberty of the Indians to enter the district, but was refused. From further information it would appear that these, as well as the San Blas Indians, a warlike tribe inhabiting the region to the south and west of Portobello, are not very safe people to be among.

Different, however, is the character of some of the remnants of the old Indian tribes of the Andes. I have travelled in these regions for thirteen years, nine years of which I have lived with Indian tribes and communities. Among these Indians I saw many excellent examples of kindness, frugality, modesty, propriety, honesty, and humanity. While with them I first began to learn and comprehend the value of those grand but simple principles, which, when properly directed and administered, bind a tribe or a nation together and form the *razon* and the science of government. Unencumbered by useless trap-

pings and formalities—which waste time and produce diseases—and unbiassed by the hideous ferocity of religions—these Indians have lived for many thousands of years without creating among themselves victims of insanity or a long category of nervous and epidemic debilities. I found no cases of insanity amongst the Indians.

Traces of Ancient Indian places of habitation.—In the search for India-rubber plants a large flat Indian mound was discovered surrounded by thick forest. The soil on examination was found to contain many fragments of pottery.

Everywhere in these forests traces of ancient towns and habitations are to be met with.

Farther to the southward in the region of the Andes exist proofs of a more extensive character of human occupation. In the hot littoral districts and banks of rivers, as well as in the dense lofty forests of the slopes, and up even to the towering brows of the *paramos*, we find a marvellous abundance of pottery and stone implements, together with burial mounds and deserted, overgrown sites, the remains of extensive *poblaciones* long since passed away. The numerous ruins of aqueducts, causeways, roads, and temples shew that those nations had attained to a comparatively high degree of rational and useful civilization.

Return journey—wreck of the "Shannon," and arrival in England.—On the 2nd of September I reached the Panama line of railway and went on with the collection of plants to Colon. The negro population, both at this place and at Panama, are an insubordinate class of people. Passengers are often insulted and robbed by them, and even the chief managers of the railroad have been menaced in the most outrageous manner.

On the 6th, I embarked on board the Royal Mail Steamer "Shannon," which was destined for Southampton. Few passengers went on board at Colon, but Mr. Wehner, a Manchester merchant, and others came with the ship from Savanilla. The Captain shortly after leaving Colon fell ill, but all seemed to go on well until about 4 o'clock of the morning of the 8th, when the ship, which was running at the rate of 13½ knots per hour, struck on the "Pedro bank," a reef of rocks off the coast of

Jamaica and about 80 miles from Kingston. At the time of the accident I was lying awake in a cabin in the fore saloon, when I felt the ship go scratching over an object and almost immediately after she struck—the blow sounding like a stupendous explosion. I knew something serious was wrong. It was as yet dark, but not very dark, the atmosphere was quite clear without fogs or watery exhalations, and the weather was calm and uncommonly fine. Day soon began to break, and a low reef was apparent about half a mile distant from the ship over which the white surf was breaking. The position of the ship was now ascertained. She had gone right over a reef—which she only grazed—and struck on another with such force that her bow went up nearly four feet out of the water. The ship had in fact gone into the middle of a shoal of rocks—and her situation was in reality a sad one. The Captain, however, made every possible endeavour to save her. At 8 A.M. a boat was sent to Kingston for assistance. On the 9th cargo was got up and thrown overboard and the engines backed—but although the ship seemed lightened, she subsequently swung round on the rocks which surrounded her. The "Shannon" was above 4,400 tons, and was built by Napier of Glasgow. Her fore part was immoveable, but the stern bumped and struck against one or other rock at least three times per minute. At times I counted nine blows in two minutes. Each shock produced a vibration like the concussion of a large steam hammer. From the time she struck at 4 A.M. of the 8th until 5 P.M. of the 10th, when I left her, this massive ship resisted *above* 10,000 shocks and still remained comparatively uninjured. I made a remark to Mr. Thomson, the first engineer, and his answer was "she is just as strong as iron could make her." The sea water around, for about a hundred yards, was quite white and thickened with the ground up coral rock, produced by the friction of the keel on the reef. On the night of the 9th I attempted to sleep on the platform at the wheel, but the shocks threatened to pitch me off and on to the deck with violence. I then went down to the fore saloon, and slept soundly for one or two hours, during which time the remaining passengers were congregated about the quarter deck. At daylight the ship began to make

a little water beneath where the engines were located. The boats were then lowered, and the passengers were dispatched, but I remained on board as I thought the ship would last until we got assistance. In about two hours later the British Man-of-War "Dryad" came in sight, picked up the boats and afterwards took off the mails and treasure. I left the wreck with a boat which came for luggage on which I succeeded in transferring the boxes containing the India-rubber plants.

Proceeding from Port Royal in a tender I reached Kingston about 2 A.M. of the 11th. On landing we were beset by a number of negroes, some of whom would insist on dragging the luggage about, and in this way a fifth of the rubber plants were bruised or injured. After a detention of three days, we went on board the Company's Steamer "Nile." All regretted the loss of Captain Leeds who has always been popular with passengers. The steamer reached Southampton on the 2nd of October.

Growth of the plants.—On arriving at Kew with the plants I had every facility afforded me by Mr. Smith, the Curator of the Botanic Gardens, for getting them re-established. On being sorted out I found fully one half had been injured or dried up. The remaining plants were put in a proper place to make growths, but these at first pushed very slowly, as the season at which they arrived is the worst in the year for the development of most kinds of tropical plants. At this time also the temperature in the warmest hothouse in Great Britain is generally ten or fifteen degrees *below* the natural heat in the forests of the Isthmus of Darien. Besides this there is a diminished amount of light which is an item of importance. On the whole every thing considered I have thought myself extremely fortunate. The plants are now progressing perfectly satisfactorily and most have commenced to push vigorous shoots. The collection, in all, will fill two cases, and may be ready to travel any time after Christmas.

I might possibly have procured the plants at one-half the risk, expense and fatigue, but then I could not have properly become acquainted with the *habitat,* and other circumstances, which it is necessary to know in successfully cultivating the tree in India. Besides the tree can certainly be relied on as of

the best variety yielding the rubber of commerce of those regions.

I have seen a few plants of a different variety or species of *Castilloa* at Kew, and also at a London Nursery, but have not been able to learn from what region these have been obtained. The leaves are very long and narrow with not very prominent veins, and the plants, at least those at Kew, show a strong disposition to "head," an indication which I have nowhere seen in the India-rubber tree of the Darien Isthmus. A completely distinct species of tree, whence rubber is likewise obtained, was seen by me in a locality near the Gulf of Guayaquil. My attention was called to it by the native collectors, who spoke of the large size to which it grew. It has no branches, but simply pinnate leaves from three to five feet in length, which form a large tuft on the top of the trunk like a gigantic grass tree. It seemed to be circumscribed to a limited extent of country.

Cultivation of the tree in India.—So far as I have been able to judge it seems to me there is a good prospect of success in all the Southern regions of India, Burmah, the Malay Peninsula, and the Islands of Ceylon and Borneo.

I do not know if it would be advisable to try the tree any farther north than the latitude of Bombay where the temperature, according to Dr. Brandis, does not fall below 60° Fahrenheit. But in all the hottest regions of India to the southward, where the *lowest* temperature is not less than 65° or 70° and where the land is not swamp or marsh or subjected to regular inundations, the tree is likely to thrive. Although growing most freely in moist forests, yet it will probably be found to prosper well on low hills as well as sloping plains, if there is some moisture and soil sufficient to nourish a banyan or a jack tree. The hot moist more or less wooded regions extending from the base of the Neilgherry hills towards the Malabar Coast are, as far as I can remember, specially adapted for this species of India-rubber tree. It is very suitable for planting along the sides of river banks, canals, streams or water-courses.

The banks of the Ganges might be a fit place to plant groves of these trees. But now a person has informed me that the

temperature at Calcutta has been known to fall as low as 45° Fahrenheit. I would not say that the tree would suffer from so low a temperature which of course would only be temporary, but probably it has not been subjected to such in its native country. Dr. Brandis gives the lowest temperature of Calcutta at 49°. I have wearied myself in looking for satisfactory information regarding the *lowest* temperature of many regions in India. This vital point, so useful for many things and purposes, seems to have been much overlooked. The "maximum" or "mean" records are of little importance—the essential point is to ascertain the *lowest* temperature which may have occurred in any district.

Although the tree will probably prove remunerative, even if planted in gardens or on the banks of rivers, yet it is likely to prove much more so when cultivated in large plantations containing several thousands of trees. The propagation is easy; green shoots and pieces of the branches or mature stem about a foot long with a bud at the top root very quickly, if put into the soil soon after being taken from the tree. The tree may be permanently planted out by merely turning over a spadeful of soil or by loosening and cleaning about a square foot of earth. No doubt the employment, when planting, of a little wood ashes, burned earth or decayed leaves would prove beneficial. *In this and all other operations of forest planting, when the development of the trunk is desired, I would always give the plants an opportunity of forming tap roots.* But whatever method is found most expedient, the formation of plantations cannot be expensive. The tree grows so rapidly that, once it is above the usual growth of weeds and shrubs, it is not likely to be overtopped.

The natives told me that in about four years young plants grew up to be trees. However, I think six years might be allowed for the developement of a tree 16 or 18 inches in diameter. The produce of such a tree would then be 25 pounds. For a tree of this species 18 inches in diameter Collins gives a yield of 50 pounds of India-rubber. As a tree becomes older its produce would increase, but taking a plantation generally it appears to me a safe calculation that each

tree on an average would produce 25 pounds of rubber per annum.

A fairly grown plantation six years old would be worth, at the lowest computation, £6 sterling per tree. I have made these remarks to shew that, if the tree succeeds, as I fully expect it will, no other tree or plant yet introduced into India will compare with it in the rapid and ample return it is likely to make to the planter.*

I have handed to Mr. Markham a specimen of prepared India-rubber and leaves of the tree, and have pointed out from a small map the chief districts visited by me in collecting.

In conclusion, I trust that this work, in so far as it has been performed, will merit the approval of the Secretary of State for India in Council and other Officers entrusted with the Government of India.

FULHAM, LONDON, *November* 1875.

The Special Survey Branch.

By C. F. Amery.

Some three or four years ago the Government recognised the desirability of appointing a special working plan branch in connection with the Forest Department. The heads of the Department had urged it upon the Government, who admitting the force of the arguments for the introduction of systematic operations under which the fellings of every year should bear definite and ascertained relation to the annual productive capabilities of the Forests, assented to the organisation of the special branch whose duty it would be to take stock of the Forests and frame working plans in accordance with their capabilities. But sanction having been accorded, it appears that it was then for the first time recognised, that of the very few men in the Department possessed of the requisite technical knowledge, hardly one could be spared from his present post; and, probably too, it occurred to the head of the Department that no amount of technical knowledge would enable an officer* to

* On this point we shall do well to let actual experience in India speak.—The Editor.

grapple fairly with the problem of supply and demand, and the fluctuations in demand which the rapid contraction of Forest area, especially of that in private hands, is likely to give rise to within a single rotation, and so the idea of a working plan branch was dropped, and a special survey branch substituted for it.

The survey of a Forest is the first essential preliminary to the framing of a working plan for it, and Captain Bailey on his appointment to the command of the party, having been instructed to survey the Dehra Doon Forests, and finding that there already existed a map of these Forests on the scale of half an inch to the mile, naturally concluded that this style of map fell short of what was required as a basis for working plans; and, apparently animated by a determination to make his maps all that they should be, procured a short leave of absence, visited the Forest Bureaus of France and Germany, saw the maps in vogue there, returned to this country and completed the survey of the Dehra Doon on the four inch scale, at a cost of one lac and twenty five thousand rupees. In round numbers, two hundred and fifty rupees per square mile.

I am far from wishing to find fault with these maps, or with the cost of the survey, which is probably the most perfect work of the kind that has ever been executed in India, on so large a scale. I am very far from wishing to find fault with the appointment of a special survey branch, which on the contrary I hold to be of first rate importance for those Forests which have not been surveyed, and which the Revenue Survey Department would probably not be able to take in hand for years to come; but, I am of opinion, that for Forests of which even approximately accurate maps on any scale exist, a new survey is not only not necessary, but absolutely useless in the present undefined state of Forest rights, and that for Forests which have not been surveyed, a survey on the four inch scale, excepting for plantations of a few thousand acres in extent, is simply waste of money. A survey on the one inch scale, with its several blocks enlarged to the four inch or eight inch scale by pentagraph, as convenience may demand, would amply

meet all the requirements of the Department for the next fifty years, and could be executed in a fourth of the time with a proportionate reduction in cost.

A Forest map to be of any value should be on sufficiently large a scale to admit of the representation of the general features o. the Forest, it is intended to illustrate. Anything beyond this is superfluous, and the error in basing our maps on the European model, originated in the assumption that our sytem of working could be immediately made approximate to the European system.

In Germany, maps on at least the four inch scale are indispensable—very few executive charges exceed five thousand acres, and even a forest of this size will sometimes be divided into two or three primary blocks, each of which is cut up into as many subdivisions as there are years in the period of rotation, especially in Forests worked by rotation of area. The data furnished to the central bureau embrace all the main features of each subdivision, age, class, and general condition of the standing crop, and it would hardly be possible to illustrate all these conditions on a scale of less than half an inch square for each subdivision. The supply too precisely equalling the demand, every tree can be cut out and sold at maturity, and the price of wood having a steady upward tendency and the rate of growth being accurately predetermined, the working plan aims at nothing short of forecasting the budget estimate for as much as twenty years-ahead, and to test the correctness of such estimates, first class maps on a large scale are absolutely indispensable. This differs widely from the conditions of forest administration in India. Here it is impossible to forecast the possible relation of supply to demand in the immediate coming future. There is no demand for any, but some half dozen of the most valuable timbers in the State Forests of India. The great bulk of our timber grows only to decay, thus supporting the view that we have more Forest area than we require, but year by year thousands of acres of Forest area give way to cultivation, the Timber sells for whatever it will fetch, the object of the owner being to clear his land, and these operations glut the market to such an extent, as to leave us no definite idea of what the demand upon our Forests will

be some twenty years hence, when other sources of supply are exhausted; and met by this difficulty at the outset, it is impossible to estimate rate of increment in Forests in which mature timber is passing to decay, or to determine the measure of demand in any given future period; hence, it is generally impossible in any but forests of first class timbers, to frame any but the most superficial and provisional working plan, based generally on the standing and prospective crop of such timber or other Forest products as are in present demand; and it is not likely that our system of working these for many years to come, will embrace their subdivision into areas so small, that their general features with all necessary information may not be adequately illustrated on maps with a scale of an inch to the mile.

Moreover reference has already been made to the unsettled condition of Forest rights, and whatever policy prevail, these will have to be adjusted in some form or other. The present policy appears to be to admit all claims and compromise them by giving up one part of the Forest for an absolute control of the remainder, and wherever this course is adopted fresh demarcations and surveys will be necessary, thus rendering the most perfect surveys incomplete. In fact such perfect surveys if not altogether useless for Forests liable to early and possibly to frequent modification of boundaries, are not of sufficiently practical value to justify the outlay incurred on them. All that is wanted in the present state of Forest management in India, is a tolerably correct map on the one inch scale, giving the boundaries and all important features such as watersheds, streams, roads, &c., and guided by these natural or artificial subdivisions, stock might be taken as a basis for a preliminary working plan. Excepting in such cases as it may be proposed to frame separate working plans for areas not exceeding twenty thousand acres, the revenue survey maps on the scale of an inch to the mile are models of practical usefulness, and even for the small areas above indicated, it would not generally be desirable to incur the costs of a survey on a larger scale, unless the forest is untrammelled by rights which in their adjustment are likely to entail a rectification of boundary.

The difficulties in way of preparing such working plans for our Forests as it would be prudent to accept as safe-guides to the operations of the next century or even the next twenty years, are such as fairly justified the negation of the original proposition for the organisation of a special branch for their preparation; but it was quite possible with the means at command to collect data of infinitely more practical importance than the re-survey of Forests, of which fairly good maps already existed. Before all things—before even maps of any sort—we want correct estimates of standing stock in all those Forests of Teak, Sâl, Deodar, &c., the timber of which commands a ready market. Without such data the sanguine man annually fells double the quantity of timber his Forest is capable of yielding, while the cautious man felling as much below the mark maintains old timber, making no increment, to cumber the ground; the first course is fatal to all hopes of future revenue the second still more fatal, since it sacrifices the possible revenue both of the present and the future. Now without a survey, or maps of any kind, the valuation surveyor by accepting natural subdivisions, or cutting lines where no such natural subdivisions exist, could parcel out his forest and determine the stock on each block, and where and how much timber might be felled annually so as to utilise all the resources of the Forest without prejudice to their permanent maintenance. It is quite true that our imperfect knowledge of the rates of growth of our various valuable trees at their several stages may to some extent vitiate our calculations, but with a precise knowledge of the amount of stock at a given period, the recognition of our liability to err in our estimates of rate of growth, would soon enable us to check them.

Calculations deduced from the valuation surveys of lines or sample areas, are of little practical value, except for forest blocks on level ground uniformly stocked with trees of uniform size and age—what we want are complete valuation surveys, dealing with every standing tree of, say eighteen inches in girth, and upwards, and this could be thoroughly performed, and a vast amount of valuable data collected at a cost per square mile below that incurred for the Dehra Dun survey.

The most important factor in this operation and that entailing most labor is ascertaining the girth measurement of the trees at base, and this can be as well performed by a native writer on ten rupees a month aided by a chuprasy on five rupees, as by the most scientific European.

A party of twenty such couples, the writer armed with pen and ink at his girdle, and a book in his hand, and his assistant with measuring tape in one hand, to help in measuring, and a paint pot and brush in the other to mark the measured trees, would get over a considerable area in a day, chronicling the class and girth of every tree; while the officer in charge of the party, would take and register height measurements for age and class, and stock his note book with observations on the general condition of the block, soil, undergrowth, natural reproduction, &c., and should also be attended with a couple of coolies carrying a chain for the rough measurement of compact blocks of saplings below the minimum girths measured, and by the close of the valuation survey of a division. His intercourse with the divisional officer would have enabled him to collect such information as to demand, costs of transport, &c., as guided by his knowledge of amount of standing stock would enable him to frame general proposals for a working plan.

The majority of our trained assistants are perfectly competent to perform such a labor efficiently. It is not advocated that the proposals of the valuation surveyor should be acted on as a matter of course—both the divisional officer and his conservator being furnished with statements of stock, and estimate of rate of growth should be severally invited to submit independant proposals, and the Inspector General of Forests, with or without the assistance of one or more conservators taking these various proposals inot consideration, would be in a position to lay down a definite plan of operations which might be safely adhered to, for at least some years to come.

My observations and enquiries have furnished me with ample reason to believe, that if we could now get a valuation survey of the standing stock in State Forests as it existed ten years ago, some of our officers would be aghast at the dis-

covery of the extent to which the stock of those timbers most in demand has depreciated. The disappearance of such trees as Toon, Sissoo, Khair, Ghoosun—trees in great demand, but nowhere covering large areas is specially observable. The run upon them constitutes an important item of revenue for a few years, and officers being frequently transferred from division to division, their disappearance is unnoticed until the revenue from them ceases altogether. And this is not only the case with these trees of minor importance. The Deodar Forests of the British Punjab, supposed to be inexhaustible fifteen years ago, exist now only in memory, and the bulk of our Deodar is drawn from foreign territory, and there are grounds for believing that our standing stock of Sâl and Teak are undergoing unmarked, but steady depreciation.

I do not recommend "taking stock" as a panacea for all our difficulties—it will not reduce Forest rights to their legitimate dimensions, keep out fires, nor secure reproduction, but it will render it possible for us so to adjust our operations to the known capabilities of our Forests that there can be no further depreciation of any valuable stock without our recognising it, and enable us to determine in what cases it would be prudent to resort to artificial regeneration to balance the supply of any given class of timber against the demand.

When this has been done, when the Forests shall have been divided into blocks, and the stock in each block determined, when Forests rights shall have been made the subject of legislation intended to be final, when in fact our Forests shall be subject to no changes, save such as can be predetermined, a resurvey of them will be desirable; but, meantime, let us be content with such inexpensive surveys as are sufficient for our present needs, bearing in mind always, that the most costly surveys of to-day will be inadequate to our future requirements.

Lastly, I do not think it will be good policy to act on the present proposal to swell the Survey Branch by drafting trained Foresters into it. These men have been trained at some expense to the State—in their present positions they are acquiring a practical knowledge of Forest matters, which will enable

them to raise the present standard of Forest management; and to take them away from their own proper profession, for work for which professional surveyors are always available, appears to me to be a mistake. In France and Germany surveying is very properly made a part of a Forest officer's training. The smallness of his charge leaves him ample time for its exercise, in measuring up areas damaged by storms, &c., but in the large Forest charges of India it is not only not necessary that the Forest officer should be a surveyor, but I venture to say that every day spent by a Forest officer in (mere area) surveying, is a sacrifice of time that might have been devoted to more important objects, in the foremost rank of which I would place, valuation surveys of standing stock.

II. Reviews.

Hints on Arboriculture in the Panjab by Berthold Ribbentrop—1874.

Notes on Forestry by C. F. Amery—1875.

The recent appearance, both in India and in Europe, of several articles and pamphlets relating more or less to the work of the Forest Department in India is a noteworthy sign of the times and promises to bear good fruit in the immediate future. From the organisation of the Department more than 13 years ago until the publication in 1874 of Dr. Brandis' admirable Forest Flora of North-Western and Central India, our Forest literature consisted entirely of Official Reports, from the perusal of many of which, we confess, we rose without having added a single fact to our scant knowledge of the physical and economic conditions of Indian Forests. Latterly, it is true, every official document bristled with words of awful sound and pregnant meaning—*Working Plans, working by Rotation, Valuation of Stock, Capability, Normal Annual Yield, &c., &c.*, when we enquired what had been done to give these terms an objective as well as a subjective existence, we found that, with a few exceptions, they still floated about dimly in the limbo of speculation sighing, "till hope grew faint and turned to dark despair," for the moment of their delivery. In a word, we found, and we say this with feelings of shame and regret, that after an existence of more than 11 years, the Forest Department still stood undecided at the very point whence it started, forgetting its sacred but ungrateful mission and sacrificing to the Mammon Revenue the already exhausted resources bequeathed to it by centuries of waste and improvidence. But we forget that no one will thank us for these doleful reflections, into which, in spite of ourselves, we have fallen while examining the books now under review.

The first of these, under the very modest title of *Hints on Arboriculture in the Panjab*, contains a succinct *résumé* of the

general principles of sylviculture with some directions on the rearing of avenue and ornamental trees, followed by a special account of the principal indigenous trees of the Panjab. It forms only part of a more comprehensive work which the Author "intends to publish in the shape of Pamphlets for the use of untrained Forest Officers." The title of the book disarms all criticism, and we defer a detailed examination of it until the appearance of some more parts. But we cannot help regretting that Mr. Ribbentrop did not select a more ambitious plan for the present volume, and give us a fuller account of the various operations of Forest culture. For instance, many Sections of Chapter II on Natural Reproduction are very meagre and unsatisfactory, and might with advantage have been drawn out to three times their actual length. The inevitable consequence of the plan adopted is that the usefulness of the work is to a great extent marred by the uninviting style, which brevity of expression has forced upon the Author. Moreover the book exhibits signs of having been written in haste, otherwise such terms as "*preprations* of the soil" for "*methods of cultivating* the soil," "*coppices*" for "*coppice clumps*," "*productive* seeds" for "*fertile* seeds," and many others that we need not enumerate, would not have disfigured this very useful book.

We are also of opinion, although the majority of our readers will probably differ from us, that too much relative importance has been given to Artificial Reproduction. We believe that sylviculture in India is incompatible with sowing and planting, except in so far as they are the handmaidens of Natural Regeneration, or when new forests are to be created. To take two extreme instances, from the Panjab and the Central Provinces respectively. In the former Province the average cost of plantations has been, inclusive of salaries of Executive and Control Officers, about Rs. 30 per acre (irrigated land.) The rotation being 15 years, the outlay per acre at the time of exploitation would, at 5 per cent. compound interest, reach the high figure of Rs. 62. Say that the average yield per acre per annum will be 100 maunds (a very high figure) worth Rs. 8 standing. Deducting from this interest

on Rs. 62, we have scarcely Rs. 5 left to pay cost of supervision and control, and upkeep operations and leave a margin for profits. In the Central Provinces, where, when there is at all a brisk sale for fuel, the price of standing material is about Rs. 2 per 100 maunds, and where the yield from indigenous species is considerably smaller than in the Panjab, the gross returns would scarcely cover half the interest on outlay alone.

In spite of the defects we have indicated, Mr. Ribbentrop deserves the best thanks of all Forest Officers and those District and Public Works Officers who are entrusted with the management of Forests or the planting of roadside trees and groves, for having laid before them, for the first time in an English dress, rules of guidance, where previously all was haphazard and groping in the dark, depending on the whims and caprices of individuals.

If Mr. Ribbentrop's little book was urgently called for to supply, even to a partial extent, a long-felt want, it is, we admit, beyond the little ingenuity Nature has endowed us with, to discover the motive that has led to the publication of *Notes on Forestry*. This little octavo volume of 119 pages, of which 10 pages are occupied by the preface under the dignified title of Chapter I, is intended to "lay down general principles in such clear language that one who had never before given the subject (Forest Management) a thought might rise from its perusal with a good general idea of what to do and how to do it."

Chapters II—V and X—XIV are respectively devoted to Sowing, Planting, Thinning, Felling, Simple Coppice, Coppice with Standards, Selection-felling or *Jardinage*, High Forest and "Timber Forest with Coppice," subjects that are treated with infinitely more detail in the *Hints*. The only subjects touched upon by Mr. Amery, which the last-mentioned work passes over in silence, are Timber-transport, Measurement of Timber, "Taking Stock," Working Plans, "Period of Felling" (Exploitabilité) and Conversion into High Forest. But here again Mr. Ribbentrop in the Conference Report of 1872 and in his Working Plans of several Panjab Forests, Dr. Brandis

in his various Official Writings on Working Plans, Hoppus in his Tables, Captain Walker in the Reports on Forest Management published by the India Office, besides the numerous papers on the slides and tramways constructed in Bombay and North-Western India, afford 10 times more information on the first four subjects, than the fleshless and very incomplete skeletons supplied by Mr. Amery. Conversion into High Forest and the considerations that regulate the various ages at which a forest might be cut with greatest advantage to the proprietor (pithily termed *exploitabilité* by the French) are broached for the first time in a publication meant for India, but these are subjects that require each of them as many pages as the whole pamphlet before us contains in order to be treated in an elementary though full manner. Having glanced over the range of subjects Mr. Amery attempts to deal with, we will now trouble our readers with some remarks on the value of the information he gives.

On page 14 he says that "such is the rapid growth of some of our trees in their earlier stages, that it will probably *not* be desirable to extend the period (between the first regeneration or seed-cutting and the final or clear-cutting) beyond two or three years!" We suspect Mr. Amery judges of the growth of self-sown seedlings from his experience of nursery plants, or perhaps he has in view the fabulous growth of the *Casuarina equisetifolia* reported from the Madras Presidency, which however is still an exotic. To take one of the most favorable instances, that of Teak, we know that artificially raised seedlings attain a height of from 15′ to 35′ with a girth of from 5″ to 13″ in the first three years, the average being about 19′ with a girth of 7″; whereas the average height of a natural seedling of the same age is, if we are not mistaken, scarcely 8′ in Burma and on the Western Coast of India, and seldom exceeds 3′ in the Central Provinces, with a proportionately diminished girth. The early growth of Sâl bears no comparison for rapidity with Teak, and the same is true for nearly all, if not all the species that are the natural companions of Teak and Sâl. It is evident then that, even under the impossible suppo-

sition that a full crop would come up the very year of the primary cutting, Mr. Amery's figure is *by far* too low.

Again on page 15, the plan recommended for substituting "another class (*sic*) of tree for that now growing in the forest" is opposed to all experience. It can never succeed unless the new species is better adapted for the locality than the standing one, and the very fact that the latter actually occupies the ground is *primâ facie* against such a supposition. In Europe where the oak has disappeared by the encroachment of the beech, the process of reintroducing the former is by no means found so easy and economical a matter as Mr. Amery makes it out to be. The same over-riding of experience pervades the last paragraph of page 16, turn up the sods as thick as you like, the ground will cover itself with grass of stronger growth than the seedlings, except in temperate climates where the grass is naturally low.

On page 19 Mr. Amery states, that the Sâl seed germinates on the parent tree, and yet he says immediately after that it may be kept for "a few weeks spread out on sand in a shady place and well sprinkled with water twice a day." Is it possible to reconcile these two statements? Now it is a well-known fact that the Sâl seedling, including the developed radicle and plumule, attains a length of more than 6″ as soon as germination is over. Can plants of this size be kept spread out on sand with the air playing all round them for several weeks? The fact is that though many seeds *do begin* to germinate before they fall, the majority do *not*, and we are personally acquainted with at least one case in which the seeds stood a transport of several days without any special precautions, such as watering, &c. The statement on page 20 respecting Teak seeds is also too general, there being frequent cases to the contrary.

Passing over other *slips* of this kind we will turn over to page 36, where directions are given relative to the method of growing large trees of species that are too light-loving to prosper in close plantations (*i. e.*, forming a leafy canopy overhead). "Thinning out should be resorted to directly their branches

come into contact with each other, and when the forest has attained the required height, the thinning should be so sharp as to leave every tree standing alone." Now in the first place, if a species requires such severe thinnings, individuals of it will never close in with their crowns, and conversely if the individuals join their crowns, they do not require such a "sharp" thinning; and in the second place, if the trees are to be isolated at such an early age as that at which, especially in this country, they attain the "required height," what ought to be done to prevent the "forest floor" from degenerating into rank grass lands? The broad general rule to follow in dealing with such species is to thin *frequently* without ever breaking the leaf canopy overhead, but gradually increasing the thinnings in severity, and never to grow them pure but in company with shade-loving trees, which do not attain the same height as themselves, and which, therefore, while protecting the forest floor and drawing them up, leave the greater part of their crowns free.

Not to exercise our readers' patience too far, we will now pass on to Chapter VII., page 55, on the measurement of timber. We fail to perceive the utility of the diagrams on page 58 with the accompanying word—description. It would require no more knowledge of mathematics than Mr. Amery grants in his readers to take at once a cone and show the inaccuracy of the practice of taking the mean diameter of round logs at the middle. Clearness is in no wise aided by redundant words and diagrams. But this is only a venial defect of the Chapter in question. There is some most extraordinary blundering in the arithmetical illustrations, which we would fain, for Mr. Amery's sake, attribute to the printer, but that its occurrence is too general to admit of such a supposition. For instance:—

$$\frac{12^2+6^2+12\times6\times25\times0{\cdot}7854}{3\times144}=3{\cdot}69$$

and not 11·45, which, however, is the correct result obtained by writing the above, thus:—

$$\frac{(12^2+6^2+12\times6)\ 0{\cdot}7854\times25^1}{3\times144}$$

Again the arithmetical processes on page 60 are incomprehensible; they ought to have been written as follows :—

$$\frac{1}{144}\left(9^2+\frac{12-6}{12}\right)0{\cdot}7854\times 25=11{\cdot}45,$$

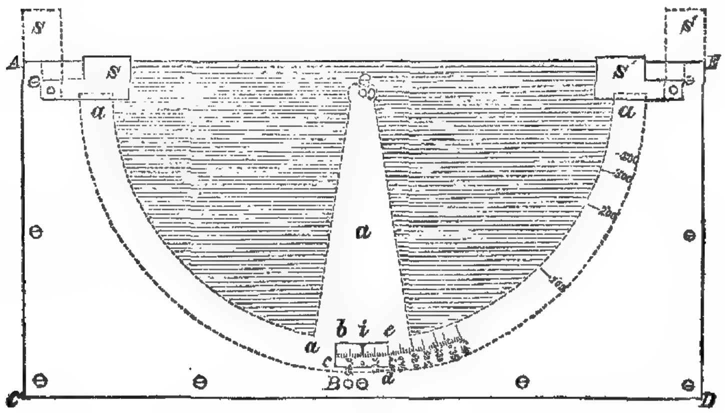
$$\frac{1}{144}\left(\frac{12^2+6^2}{2}-\frac{6^2}{6}\right)0{\cdot}7854\times 25=11{\cdot}45,$$

$$\text{nd}\ \frac{1}{144}\left(9^2+\tfrac{1}{3}\times\frac{12^2+6^2}{2}\right)0{\cdot}7854\times 25=11{\cdot}45.$$

The hypsometer, or dendrometer, figured on page 62, is one of the most awkward to use, as well as to carry about that can be imagined. In the first place dividing the sides of the square board into 10 equal parts is not sufficient, for if each part is to represent 10 feet, then there must be smaller sub-divisions to represent every two feet if not every foot, otherwise it would be impossible to read within three and even four feet of the correct height, and this all the more the greater the divergence of the line of sight from the horizontal. In the second place, in a hilly country, it is seldom possible to choose a convenient position, and the observer may thus be obliged to station himself a good deal above or below the horizontal line passing through the base of the tree; in such a case he would be obliged to shift the plumb line from *E* to *D*. In the third place, what is to be done when the ground is too rocky to allow of the "stock" being fixed firmly in position? We could multiply the defects of this instrument, but they will be obvious to any one. We will not say anything about Mr. Amery's expression of a "line intersecting a point," but describe the dendrometer of M. Bouvart, which is the best we have ever seen, and which does not appear to be known to the generality of Indian readers.

A C D E represents two thin boards firmly riveted or screwed together at their edges, and hollowed out (*vide* shaded part) so as to receive between them a graduated brass arc, *a a a a*, oscillating freely round its centre *O*; *b c d e* is a rectangular opening in the upper board, through which the graduations of the arc are seen; *i* is an index to read off the graduations with, coinciding with zero when the line of sight is horizontal; *B* is a button which, on being pressed, sets free the gra-

duated arc, which is otherwise stopped by a spring; *S S'* are



brass sights represented, folded down and put up when in use, *S* containing the pinhole, *S'* a larger opening with a hair stretched across it horizontally. It is evident that the height of a tree is equal to the product of the distance of the observer from its base and the tangent of the angle of elevation. If the instrument gave degrees and parts of a degree, the use of mathematical tables would be indispensable; but the arc is so graduated that each graduation gives the tangent itself of the corresponding angle of elevation. The graduations rise both right and left by hundredths, thus 0·00, 0·01, 0·02, &c. The reason for graduating both legs of the arc is, that when the eye of the observer is not in the same horizontal plane as the base of the tree, he directs the instrument both on the base as well as the top of the tree, and takes the sum or difference of the two readings for the required factor according as his eye is above, or below, that horizontal plane. The demonstration of this is evident to any one acquainted with the mere elements of Plane Trigonometry.

We will pass over without remark Chapters VIII. and IX., though the temptation to say something is almost irresistible. With regard to Chapter X. it will suffice to say that the decay of the stool is no disadvantage in coppice. If the stools have been cut low enough for the shoots to spring up from near the

ground (and in the case of the *Ber* many will come up from below the ground), the shoots soon develop their own roots, and the stools invariably die at length by atrophy of their roots, but the shoots themselves yield the stools of the next following exploitation. Hence is explained the indefinite duration of forests worked from time immemorial as simple coppice without any aid from artificial reproduction.

In Chapter XI., page 84, the extraordinary statement is made that in coppice with standards you can "*never* obtain timber." We ourselves have seen forests of mixed oak and beech with *numerous* standards, in which the average length of bole of these latter was scarcely inferior to what would have been produced in a high forest, and it is a patent fact that oak coppice standards supply no inconsiderable portion of the timber used in the French dockyards. From this it will be evident that the German Forest Officers, with whom Mr. Amery came into contact, had generalised from insufficient data when they concluded that "leaving more stems at every felling than was consistent with the ideal theory of a mixed forest" was the cause of the unsatisfactory state of the forests referred to.* In fact by carrying this system a step farther, you obtain in a short time a forest which the unpractised eye would easily mistake for a regular high forest.

In Chapter XII. an equally extraordinary statement is made that the Placenterbetrieb system, in the final period, affords light-loving trees that free space which they cannot get in "close forests," by which we suppose Mr. Amery means regular high forest; on the contrary this latter system by localising the age, groups is much more favorable for graduating the quantity of light to the requirements of every tree.

On pages 103 to 105 is sketched out an instance "sufficient to indicate the general principles" of transformation of a forest worked by *jardinage* into a regular high forest. But our author, as is usual with him when figures occur, gets into a

* We fear Mr. Amery must have made some mistake, at any rate we never heard of the theory here propounded. Muhafiz-i-jangal, too, ought to have known that German Forest Officers are not likely to approve of what is probably Mr. Amery's theory only. We ourselves are not in favor of coppice with standards, except in cases where the area is so small, that high forest and coppice can not be adopted on separate blocks.—THE EDITOR.

hopeless confusion respecting the ages of the trees, and the example is so unhappily chosen, that to the uninitiated it would appear that two long rotations were generally required in each case of transformation. At the end of the second period the age of the trees in Blocks C and B, would range from 81 to 140 years, and in A from 56 to 115 years; but Mr. Amery makes out 61 to 120 and 1 to 80 respectively; hence in the fourth period the last trees felled in C would be all above 100 years old, but Mr. Amery says from 75 to 80 years. Again in the fifth period the trees in B would be cleared out at from 121 to 160 years of age, and in the sixth period those in A would be cleared at from 116 to 155 years, but Mr. Amery's figures are 95 to 100 years in the former case, and 75 to 120 in the latter.

We ourselves would have preferred regularising the whole forest by the end of the first 120 years, and this without requiring any more labor or expenditure than Mr. Amery's plan, and without running the risk of cutting our trees when decay had already set in (we have seen that although Mr. Amery takes the age of maturity at 100 years, he allows a considerable portion of his timber to remain standing till their 160th year).

To sum up, Mr. Amery has told us nothing new, but what we might have learnt in a much more satisfactory manner from sources available to every one, and the little he has told us, by no means gives us "a good general idea of what to do, and how to do it." As for ourselves we confess that after having during several successive years plodded through no inconsiderable portion of what the great European masters have taught and written, and after some years of experience in India, we cannot say that we have yet gained "a good general idea of what to do, and how to do it;" nor has a single one of our difficulties been at all smoothed for us by the 119 small octavo pages from Mr. Amery's too facile pen. We give it as our opinion, unbiassed by personal feelings of any kind, that these notes should never have quitted Mr. Amery's private note-book, but remained there in company with the others that he may have taken for his own profit during his few months tour in Germany; but the world

might in that case have been deprived of the extraordinary picture (*vide* cover) of an European *shikari* riding placidly his elephant down a steep, narrow lane close planted on each side with thin, tall, liane-like stems forming a shady arched roof overhead, and a tiger only two paces off amusing himself and the shikari by doing the unusual feat of twining his body round one of the said stems, and "looking round the corner."

MUHAFIZ-I-JANGAL.

The above was received by us when we had just commenced ourselves a review of Mr. Amery's "Notes on Forestry." Although we do not agree with Mahafiz-i-jangal in all details, we could not refuse to publish his review, since we agree with him, that publications like these "Notes on Forestry" should be subjected to a powerful criticism, lest it might be understood that we approve of them.

Our personal friend Mr. Amery has shown, and indeed so again in this present number of the Forester, that he possesses a great power of argument. His "Notes on Forestry" prove that he has taken great trouble to become acquainted with the principles of forestry, but that is not sufficient "*to give others a good idea of what to do, and how to do it.*" Here his pretensions go beyond his achievement. No doubt the little book gives some idea of *what to do*, but it certainly does not teach the uninitiated *how to do it.* To do this, it is far too short, and written in too general terms. Moreover, there are many mistakes in the book. Some of these have been pointed out by Mahafiz-i-jangal, to whose list we could add many more items.

In the present state of Indian Forestry, we must not waste our time in attempting to write general handbooks on Forestry, for which we do not possess the necessary material, but we should confine ourselves to treatises on special subjects, which may be published in the shape of pamphlets, in periodicals, or in reports. After each subject has been fully treated and discussed in this manner, it will be time to proceed to a com-

pilation of the experiments made, the experience gained, and the rules to be deducted therefrom. Until that time arrives, we should advise Mr. Amery to confine himself to one subject only at the time, instead of attempting to grasp the whole at once, and we have no doubt he will contribute many a useful and valuable item to the general store of knowledge, by which forest management in India should be guided.

THE EDITOR.

Notes on the effects of grazing on Sal forests in the Eastern Dooars.

After an inspection of the burned and half-ruined forests in the greater part of the Dooars, one is pleased and surprised, at the vigorous growth of Sal which is to be found in several blocks situated near some of the villages in the Sidli Dooar.

The trees are straight, with clean stems, and growing densely with little undergrowth, except a few low creepers, and Sal and other seedlings and low grass and ferns.

The *absence of fires for several years can alone have* caused such a good growth, and the burnt stumps in the ground attest that there have been fires at no very remote period. On enquiry from the villagers, it is stated that the village has been *in situ* for seven years, and that since that time the cattle have so grazed on, and trampled down, the jungle that there has been nothing to burn.

The cattle have not in any wise injured the Sal seedlings, which they do not eat, and the soil, being sandy and gravelly, *has not been materially hardened, so as to affect its permeability* for the nourishment of the roots of the trees.

These unburnt patches of Sal are of frequent occurrence in the Sidli Dooar, and the exemption from fire is everywhere due to the grazing, and to the presence of cattle.

In order to give an idea of the quantity of timber in these patches, I have measured off an acre in one of them, which is of considerable extent, 20 to 30 acres, and have counted all the trees on it.

Number of trees under $1\frac{1}{2}'$ girth.	Number under $3'$ and over $1\frac{1}{2}$.	Number under $4\frac{1}{2}'$ and over $3'$.	Total No. per acre.
11	94	44	149

The above table gives the number of Sal trees on the acre, the girths being taken at 5 feet from the ground.

There was also one Kumbi—(*Careya arborea*), all the other trees being Sal.

The surface growth consisted of short grazed grass, ferns, and dead leaves, and seedlings of Bairu, Dudhkuri, Kumbi, Khoja, &c.

The measurement of the height of an average tree, girth 3′-6″, gave 52′ to the first branch, and 79′ to the summit.

The height is very uniform, of the trees over 3′ in girth. The soil is a coarse sandy loam, with grains of mica and quartz and pebbles of greenstone and quartzite. The rate of growth may be taken roughly to be 30 years, for a girth of 3 feet, but I have not yet counted the rate of growth of a sufficient number of trees to arrive at any reliable results.

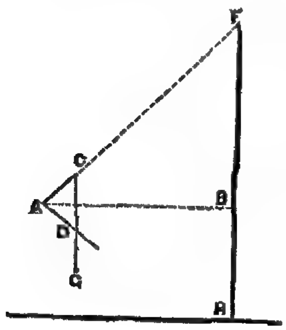
In conclusion, I believe that, when Sal forest occurs close to the boundaries of cultivated land, the presence of cattle along the edges of the forest will be a most efficient protection against fires, and therefore should be encouraged as much as possible, except in bare places which it is required entirely to restock.

W. R. F.

Fleischmann's Hypsometer.

As *G. F.* has received no answer to his query in the October number of the *Forester,* I send the following directions for making a Fleischmann's hypsometer:—

The two arms A C, A D, form a right angle at A. A plumb line is attached at the point C, one foot from A. The limb A D is two feet in length and divided into feet and decimals of a foot.



To use the instrument, align the *arm A C with the top of the tree* F, as shewn in the figure, and on A D read off the distance from A, at which the plumb-line C G cuts the arm A D. Measure the distance A B. Then,

$$AC : FB = AD : AB$$

and $$FB = \frac{AB \times AC}{AD}$$

but as $$AC = 1 \text{ foot.}$$

$$FB = \frac{AB}{AD} \text{ ft.}$$

The height above the ground of the observer's eye added to $\frac{AB}{AD}$ gives the height of the tree.

The *kluppe,* which is generally used for measuring the diameters of trees, can easily be made to serve also as a hypsometer; all that has to be done, is to attach a plumb line to one of the smaller arms at the required distance from its junction with a larger one.

JANGALI BULBUL.

Transplanting *versus* Direct Sowing of Teak.

I have been much interested in the replies to my enquiry regarding sowing and transplanting of Teak in other Provinces, and now give the information asked for by J. B.

Rainfall in Assam 70 to 120 inches, the rainy season begins first week in June and ends about the middle of October, but there are frequent storms and heavy showers in March and

April. I begin transplanting, if possible, in the middle of July, that means fill up vacancies, the seed having been sown at stakes a month previous, and do this as pointed out by J. B. for half the cost. For all this and in spite of the strictest economy in every other plantation work it costs Rs. 50 per acre at the least, and I envy J. M. being able to do the same work for Rs. 10, for, where this is possible, planting Teak might even at this early date of forestry in India, when funds available for such work are small, be carried out on considerable areas, whilst where plantations of Teak cost Rs. 50 per acre, as in Assam, we shall have to be satisfied with having established some 60 or 80 acres for our successors to be guided by some 50 or 100 years hence, and defer more extensive planting until our natural forests have by care and protection recovered from former bad usage and excessive fellings, and give a surplus revenue which would justify more expensive improvements in the way of plantations.

G. M.

I have read J. B.'s note on "Transplanting *versus* Direct Sowing of Teak" at page 192 of the *Indian Forester* in the number issued in October 1875, and I notice that with about the same conditions of climate, rainfall, soil, &c., as I have, he has been successful with Teak plants and his are all in a flourishing condition, while mine are small and very wretched specimens of plants. I should feel very much obliged to J. B. if he would let me know through this magazine, how he sows his Teak seed, how he prepares the soil, whether the seed he sows is old or new, whether he steeps the seed or not, in short, everything connected with his method of sowing, so that I may see in what I have failed, and why I have not been as successful as he was.

H. G. B.

I. ARTICLES, &c.

Remarks on the Sunderbuns,

BY W. SCHLICH.

Most people in India, at one time or other, have heard of the Sunderbuns; and those who landed in this country at Calcutta are sure to remember the low islands forming the banks of the Hooghly. The forests on these islands supply Calcutta, and indeed the Twenty-four Pergunnahs generally, Jessore, Backergunj, and other districts with timber, fuel, thatching grass, &c., and the following notes may therefore be entitled to a place in this periodical.

The Ganges and Bramaputra, the great drainers of the central and eastern Himalayas, may be said to be the parents of the Sunderbuns. These two rivers, in carrying year after year large quantities of silt from the mountains to the plains, and thence on through the numerous branches of their combined delta to the Bay of Bengal, have in course of time formed the Sunderbuns, and indeed a great portion of the plain of Bengal itself. The action still continues, and consequently the formation goes on, though it may be almost inperceptible at the time. Owing to this mode of formation, the Sunderbuns show the lowest level near the sea-face, and they rise slowly towards the north. But there appears to be a second mode of rise, and that is from south-west towards north-east, so that a point 20 miles from the sea in the eastern portion would generally be of a higher level than a point 20 miles from the sea in the western part. Hence it comes that the highest parts of the Sunderbuns are found in the north-eastern corner, near Morellgunj, and the lowest in the south-west, that is to say between the mouths of the Mutlah and Hooghly rivers. The peculiarity here indicated in a general way is of the greatest importance with regard to the vegetation, as will be seen further on. The lower parts of the Sunderbuns are inundated at every flood-tide, fresh deposits are made, until they get by degrees beyond the reach of high water, except on the occasion of spring or other exceptionally high tides, when the whole of the present Sunderbuns is inundated. Barring these occasions, the north-eastern parts are from one to two feet above high-water mark.

The soil on the Sunderbun islands, being river deposit, is of a light nature, and consists as a rule of sand and loam mixed in different proportions, occasionally also with clay, and now covered with large quantities of vegetable mould. On the whole *the soil must be very fertile; but owing to the inundations by* salt water, it is adapted for certain kinds of vegetation only.

For many years past, as the formation of soil proceeded from north to south, and as the northern islands rose above high-water mark, cultivation seems to have proceeded in the same direction, and so we find now the northern parts of the Sunderbuns under cereals. But still a large area is uncultivated, and it is with this unleased portion that we have to do in the present instance.

The vegetation in the Sunderbuns comprises about 40 different species of trees and shrubs; of these the following three are the most characteristic:—

GORAN	... *Ceriops Roxburghiana.*
GANGWA	... *Excoecaria Agallocha.*
SUNDER OR SINDRI	... *Heritiera littoralis.*

To these should be added two palms—

GOLPATTA	... *Phœnix paludosa.*
and HITAL	

It appears that new-formed islands, which are still inundated by every flood tide, become covered with a growth of *Goran*, alter*nating with strips and patches of Hital or Golpatta.* As the level of the islands rises, other trees settle on them, and of these *Gangwa* is the most frequent. When the level is further raised, so that the islands are flooded occasionally only by salt-water, *Sunder* makes its appearance, and soon occupies the greater portion of the land. Thus we find the *Sunder* forests chiefly in the north-eastern portions, that is to say, on the highest lands, *Goran* along the sea-face and in the west, and *Gangwa* in the intermediate islands. It must not be understood, however, that the above general distribution is carried out strictly. *Sunder* appears vigorous and as a full-grown timber tree only in the north-east portion of the area, and it dies gradually away on proceeding to the south and west. *Goran* is most numerous in the lower lands, and it would probably grow just as well on the higher land, if it had not to give way to other trees. *Gangwa*

is most numerous in the intermediate compartments, but it spreads into the *Sunder* tracts on the one hand, and into the *Goran* tracts on the other.

Of the remaining trees the following are the more important:—

BAEN	... *Avicennia tomentosa.*
KIAURA	... *Sonneratia apetala.*
KOLSHA	... *Aegiceras corniculata.*
POSHUR	... *Carapa obovata.*
SHINGR	... *Cynometra bijuga.*
LATMI	... *Amoora cucullata.*

Sunder is of the first importance. It grows into a tree of up to 60 feet high, and of 6 feet girth, a larger circumference being rare. The heart wood is of a brownish red color, hard and very heavy, one cubic foot of green timber weighing as much as 104 pounds. It is used for a great variety of purposes, as beams, buggy-shafts, planking, posts, furniture, firewood, but chiefly for boat-building. Indeed, without this timber the boat traffic in Lower Bengal could never have reached the extent which it has now, and the permanent supply of this timber is, therefore, of the highest importance for the welfare of the Twenty-four Pergunnahs, Jessore, Backergunj, and the adjoining districts.

Gangwa grows to a height of 40 feet and a girth of 5 feet; its timber is white, and not very lasting; it is used for general carpentering purposes, for posts, and for firewood.

Goran reaches generally a height of 25 feet, sometimes up to 35 feet, but rarely more than 1 foot 6 inches girth. The wood is of a red color, and is extensively used for posts and for firewood; the bark is used for tanning.

Baen reaches a height of 60 feet, and gives a white heavy wood, very brittle, which is used for firewood only.

Kiaura grows 60 feet high, and its wood is of a light color, used for planking and firewood, but not much prized.

Kolsha reaches a height of 25 to 30 feet, and is used for firewood.

Poshur grows 45 feet high; its wood is used for building purposes, furniture, and firewood; it lasts fairly well.

Shingr, a small tree, up to 20 feet high, wood whitish, hard; used as firewood.

Latmi grows up to 45 feet high; wood white, hard and heavy; used for building purposes and firewood.

Hital is cut for rafters, which are said to last up to 15 years.

Golpatta is used for thatching all over the districts adjoining the Sunderbuns; it is said to last up to 5 years.

Most of the remaining trees are made use of, but chiefly as firewood.

Throughout the Sunderbuns the growth of the vegetation is very vigorous, and where cutting has not cleared the ground, it is covered with a dense mass of vegetation. The trees also grow very fast, and the wood-cutters say that a full-grown Sunder tree is only some 20 to 25 years old. Although this statement is not to be relied on, still there can be no doubt that it is a short-lived tree, which is proved by immense numbers of dead trees, that have evidently died a natural death. It would appear that Sunder rarely attains an higher age than 50 years.

Reproduction is most favorable. On all lands flooded by ordinary flood tides a new growth of jungle springs up immediately, where the old material has been removed, as the seeds are carried on the lands by the water. And the same may be said of the lands above ordinary floods, provided a sufficient number of seed-bearing trees remains; but where the latter is not the case, as on extensive clearings, reproduction is very uncertain, and at any rate very slow. It has been put forward that reproduction all over the Sunderbuns is unlimited, and that cleared blocks will be covered again with forest in a very short time. This view does not hold good in the case of land above ordinary high-water mark, and consequently in the Sunder tracts. If such lands are once cleared, grass will spring up, and a growth of timber trees can only establish itself by very slow degrees, and after a very long lapse of time—a fact which is proved in several places in the north-eastern Sunderbuns. The cleared land, if left to itself, will have to take its chance of a few trees settling on it; but a general reproduction will not take place until such isolated settlers themselves begin to bear seed.

As one reason that reproduction is equal to the demand, it has been brought forward that large numbers of dead trees are observed over the Sunderbuns. But on examination it will be found

that the dead trees were all of inferior qnality, either unsound or badly shaped, so that timber-cutters did not consider it paying to remove them.

The Sunderbuns yield year after year immense quantities of forest material for all adjoining districts, especially the Twenty-four Pergunnahs, Jessore, and Backergunj. Endless numbers of boats proceed in the dry weather to the forests, and return laden with timber, especially Sunder, rafters, firewood, thatching grass, &c., to supply which there is no other source available. And consequently it is our duty to see that the supply is not exhausted. Moreover, the demand is certain to increase, and we must therefore make sure that the increase also is provided for. It has been said that the supply is inexhaustible, but such is not the case. It appears, on the contrary, that the western part of the Sunderbuns, which is that nearest to Calcutta, is already exhausted to a very large extent, and that fuel-cutters proceed more to the east year after year. Even in the Sunder tracts, one sees for long distances from the rivers' banks nothing but dead Sunder trees and seedlings. No doubt the centre parts of the islands still contain large quantities of full-sized trees, but then it should be remembered that nearly all islands consist of marshy ground, and that all material has to be carried or dragged by men to the banks of rivers and nullahs, so that practically a great portion of the available stock must be considered as beyond reach. Moreover, owing to the absence of accessible and superior fuel in the western half of the islands, fuel-cutters resort more and more to the Sunder tracts in the east, and here they cut, not dry trees or the branches of trees felled for timber, *but saplings of Sunder* of good growth, which are easier to cut than dry wood, and which pack closely in the boats. Indeed, herein lies the great danger of the supply of Sunder timber for boat-building being exhausted. If the straightest and best saplings are cut for fuel year after year, and in the accessible parts of the forests, it is but natural that the supply of full-grown timber must fall short. This explains why the boat-builders in the Backergunj district, where boat-building is chiefly carried on, have complained for some years past that they cannot obtain now the same class of Sunder timber which they used to get in former years—a point to which

Sir Richard Temple drew attention in a note on *the Sunderbuns*, dated September 1874. In short, if the Sunderbuns remain open to all comers, and if *certain restrictions* are not *introduced, there* seems no doubt that the supply will fall short of the demand. *This* must be *avoided*, as no other sources of supply are available, *and therefore* the Sunderbuns should be taken under forest management without delay, instead of extending cultivation towards the south without considering to what extent the permanent yield of forest produce may be curtailed by it.

On Coomrie Cultivation,

By J. L. Laird.

The present system of coomrie, as practised in Bedi, consists in coppicing all unreserved trees on a given area, burning the leaves, branches, and other litter, and raising crops of grain by means of the manure thus obtained.

By the time two or three crops have been produced, the soil is exhausted, and the ryot finding further cultivation unprofitable, goes on to another field, which he treats in the same manner. In this way he proceeds from field to field until the scrub on the first has reproduced itself in sufficient quantity to give, when burnt, one or more crops of grain. The latter is then again cultivated, and the same process as the preceding repeated over and over again as long as the soil produces enough scrub for a *khuski* crop.

In practice coomrie is not carried on quite so regularly as might be inferred from the foregoing remarks, which shew how it would work if performed more methodically.

The best kind of land treated as coomrie requires two or three years' rest to recover sufficiently to yield another crop; so that the best soils may be said to be fallow, or unproductive—a very small revenue from reserved trees excepted—at least every other year, and inferior soils for longer periods.

It is, I think, a generally admitted fact that the fertility of land diminishes more or less rapidly under coomrie, and the object of this paper is to propose the adoption of a method of treatment, under which the deterioration of the soil might be

greatly diminished, or, under favourable circumstances, entirely arrested, and a fair rent realized at the same time.

Shortness of the revolution (which precludes all possibility of the soils recovering in the intervals of rest), and the absence of any attempt to regenerate or protect suitable kinds of trees by artificial means, appear to be radical defects of the present system.

I propose, therefore, to lengthen the revolution sufficiently, if possible, to admit of the trees attaining timber size; to protect and organize the forest; and to regulate coomrie.

I think it would be well to let the trees grow up to maturity (say 30 to 50 years, or more) whenever practicable, not only for the sake of increasing the revenue, but also in order to give the soil ample time to recover and improve. At the same time I do not see why the plan about to be proposed should not succeed with forests having a revolution (rotation) of less than 30 years—say as low as 15—but then the forest would have to be coppiced, and for obvious reasons coppice with short revolutions would be less desirable than seed woods with longer revolutions.

According to this plan the forest would be divided into compartments of equal area, their number and size, as well as the length of the revolution, depending on the area required yearly for coomrie. These compartments would be cleared of timber in regular succession by the method of 'clean cuts.' After clearing a compartment, the land would be given over for two years agriculture to the ryot, who, by preparing the ground for his own purposes, would, at the same time, thoroughly prepare it for the next forest crop. In consideration of the labour he would have in digging up roots and stumps (which he would be allowed to burn for manure), and otherwise preparing the ground for cereals, and on condition of his planting out a certain number of seedlings per acre at the end of the two years, the land might, perhaps, be given free of rent.

To make my meaning clear, let us take a forest of which one acre is required yearly for coomrie, and the revolution fixed at 20 years. Then it is evident that, if the trees in each coomrie compartment are to reach an age of 20 years, we must reserve 20 acres for the purpose. These 20 acres, having been selected and marked off, would then be divided into compartments of one acre each

and worked in regular succession, one every year, so that by the time the 20th cutting had been carried out, the first would be stocked with trees 19 years' old, and ready for the axe the following year. In this example the yearly cutting is confined to one spot; but of course this is not necessary; all that is required being, that the cuttings during one year, taken together, cover an area of one acre. I have also assumed, for the sake of shortness, that the ground is used for agriculture only one year, and that the forest is regenerated simultaneously with the sowing of agricultural seed. If the land were used for agriculture during two years, the area required would be about half (see note).

I think that, by somewhat lengthening the revolution, by carefully selecting the kind of tree, and by close planting, so as to get an unbroken cover as soon as possible, a good revenue might be derived, and the wants of the people satisfied at the same time. If we compare the long revolution during which the soil would be improving, with the short period during which it would be more or less deteriorating under agriculture, there is good reason to hope that the land would thoroughly recover before the end of the revolution, when it would again be used for agricultural purposes.

The only objection that can, as far as I am aware, be brought to bear against the method is, that to carry it out might perhaps require a greater area than would always be convenient; but the area required is not so great as might appear at first sight, and the length of the revolution would be regulated with due regard to the extent of country available, coppice being resorted to when the revolution had to be greatly curtailed. A village demanding 40 acres of coomrie yearly would require, for instance, for a revolution of 30 years, 1,040 acres altogether; but for a revolution of 20 years only 440 acres.

It must be remembered, too, that in coomrie districts the population is scanty, and the land under cultivation but a small fraction of the whole.*

* By 'coomrie districts' I mean those in which the capital available for cultivating the soil is so small, the waste land so extensive, and the people so poor, that Government think it necessary to allow coomrie.

The fact of land having once been coomried is in itself no criterion that the land is now absolutely coomrie land; indeed, if it were, all tracts now under cultivation would constitute coomrie districts.

I have taken at random six of a number of villages, the forests of which I inspected this year. The people are generally poor, although, perhaps, nowhere absolutely in want. The following table shows the lands of each village under "khuski," "tari," forest.*

VILLAGE.	Population.	LANDS UNDER					
		KHUSKI.		TARI.		FOREST.	
		Acres.	Guntas.	Acres.	Guntas.	Acres.	Guntas.
Kúmbhándé ...	254	115	36	33	5	2,961	19
Kúmratsoádi ...	?	112	27	82	32	832	6
Degegháli	192	45	38	63	14	685	4
Mumdwád Pimple ...	192	44	18	351	6	1,203	13
Somset	?	...	...	28	32	133	25
Mácháli	76	28	7	172	18	394	14
Total ...		347	6	731	27	6,209	21
Average for one village ...		Acres. 58				Acres. 1,035	

As coomrie-land is essentially khushki-land, it is not necessary, in examining the coomrie resources of a forest, to take into consideration demand for rice-land.

Supposing, therefore, the whole of the above forests could be coomried (they have already been coomried throughout), and that a revolution of 60 years is decided upon, then 36 acres could be given over yearly for coomrie; in other words, the ryots would have the opportunity of bringing under cultivation, besides waste lands, 62 per cent. more land then they now have under khuski crop. But, supposing it were thought advisable to allow only the better parts to be coomried, and that these amounted to

* *Khuski* land can only produce a 'dry' crop (*i.e.*, grain which does not require much moisture, such as wheat). The more valuable, *tari*, or 'wet,' land is suited to the growth of semi-aquatic plants, such as rice and sugarcane. The former generally corresponds to the *aek fasli* and the latter to the *dó* and *tín fasli* lands of Hindustan.

75 per cent. of the whole, then—for the same revolution as before—there would be 27 acres available yearly, or 46 per cent. more than the present area under khuski crop.

Besides the lands given in the table, there are in these 6 villages altogether 560 acres of waste land; this area gives 93 acres for each village, or nearly double of that now under khuski cultivation.

It appears, then, that in part of the Bídi táluk, at all events, this plan might succeed; at any rate, the forest area is sufficiently extensive.

It will be readily admitted that the maintenance of standards after the chief forest crop has been removed cannot fail to result in a diminution of the yield of grain—a diminution which cannot be measured simply by the quantity of nutriment absorbed by the standards, for the injurious effects of overshadowing must also be taken into account. By adopting the method of 'clean cuts,' this competition between forest and field would cease.

In the poorer parts of Belgaum and other countries this system has been in existence many years, and, I believe, found to answer the double purpose of providing a steady revenue for Government, and a means of subsistence for the people.

The following appear to be the more salient advantages of the method over the present one:—

1.—The soil would, at all events, deteriorate less, and most likely improve.

2.—Deterioration being arrested, a steady revenue be derived from the forest after the first revolution.

3.—The half measure of growing grain under standards might be avoided.

4.—The working of the forest would afford employment to the people.

In conclusion, I would remark, in order to avoid misapprehension, that I do not suppose this plan could be applied everywhere. For instance, in some coomrie districts on the ghâts the forests have been entirely exterminated, I am told, and there remains little or nothing but bare rock; of course no system of coomrie could restore the forests in such places.

Nor do I imagine that the system could always be carried out in its entirety. For instance, it might often be a dangerous experiment to dig up the roots in sloping soils for fear of the latter's being washed away during the monsoon. What I insist upon generally is, the necessity of lengthening the revolution *and of protecting and managing the forests with the same care as* would be bestowed on them, if they were never coomried; the rest is merely a matter of detail.

NOTE.—If the area of a forest (A) is divided by the length of the revolution (r), it is evident that the quotient gives the area of the annual cutting for a sustained yield (c), or $c = \frac{A}{r}$; but if each cutting is to lie fallow a number of years (n), the yearly cutting will be:

$$c = \frac{A - nc}{r} = \frac{A}{r+n} \text{ and } A = c\,(r+n).$$

Example.—A village requires 40 acres of coomrie yearly, when $r = 50$ and $n = 2$. Find the total area required.

Here the average *yearly* cutting would be 20 acres. (For the first year 40 acres would be cut, second year nothing, third 40, fourth nothing, and so on—average 20.) $A = 20\ (50 + 2) = 1{,}040$ acres.

As n would always be very small—never in fact more than 2 or 3—in practise it might be entirely neglected. For instance, it would matter very little if, in the above example, the trees were cut at an age of 48 years instead of 50.

The means of obtaining length of Stem for Timber,

By A. Pengelly, M. A.

These means are two in number; *1st,* the maintenance of the trees in a forest so close together as to kill the lower branches when still small from want of light; and *2nd*, pruning.

We will first consider the latter method, more especially as it is what seems to suggest itself to most minds on first paying any attention to the subject.

Pruning, when performed on forest trees, should be done in the following manner: The branch should be cut off close to the trunk or to the branch from which it springs, and from below

upwards, not from above downwards. *Also the surface left should* be smooth and cleanly cut, so as not to allow of the lodgment of water.

We will now consider the reasons of these rules, which it is of the utmost importance to observe when pruning has to be performed.

On considering the manner in which a wound on a tree heals, we observe that successive layers of wood are deposited by the descending sap, until at length the wound is covered over by the new sound wood formed on it.

Now, as long as the wound is exposed to atmospheric influences, it is liable to decay from the infiltration of water, &c. It follows, then, that we ought, when cutting off a branch, to cut in such a manner that the wound may be healed over as soon as possible.

That this is effected by cutting off the branch close to the trunk will be seen on very slight consideration; for suppose on the contrary that a branch be cut off at a distance, say of 4 inches, from the stem of the tree, the crude sap from the roots rises up to the leaves, where it is perfected, and descending deposits a new layer of wood. Now the sap in its descent follows mainly the law of gravity, and therefore the stump of branch left, being deprived of the leaves that were *formerly above it on the branch, and being* out of the line of the descending sap from other branches, receives no fresh layer of wood, or at the best only a very small one. Meanwhile, atmospheric influences act on the stump, and frequently decay sets in, which is often communicated to the heart of the tree.

At the same time the trunk goes on growing, and an annual layer of wood goes on forming all round the stump, which remains a piece of dead (not necessarily decayed) wood enveloped in sound growing wood, exactly after the manner of a nail. This continues until either the stump having become quite rotten drops off, leaving a hole to be grown over by sound wood, or else it persists until the growth of the tree quite envelopes it. On making a section through this part, the manner of growth can at once be seen, the stump of the branch shewing quite plainly from the surrounding portions, with which it has no connection. If, on the other hand, the branch is cut off close to

the trunk, the wound, *being in the line of the descending sap*, receives a deposit of wood every year all round its contour, and thus the exposed portion yearly diminishes until it is covered over. The wound is of course larger when this method is employed, but it is under the very best condition for healing; whereas, if the branch is cut off at a distance from the trunk, although the wound is smaller, there is little chance of its being healed, from the fact that it is out of the line of the descending sap, which is the healing power.

The precaution to be observed of cutting from below upwards is enjoined from the fact that, by cutting in the opposite direction, it commonly happens that the branch breaks off at last, carrying with it a portion of bark and wood, creating a larger wound, and one which, from not being smooth, is more likely to occasion the infiltration of water. These bad consequences are obviated by observing the above precaution.*

In order to leave a smooth surface, it is well to employ a sharp cutting instrument, not a saw; or if a saw is employed, to cut the surface over afterwards with a knife. With the same object, *viz.*, the protection of the exposed surface from atmospheric influences, it should be covered over, and for this purpose perhaps coal-tar answers best, as it is easily applied, and is very effectual in preventing decay.

In the Paris Exhibition of 1867, a very instructive series of the effects of bad and good pruning was exhibited by M. Mathieu, the learned professor of Natural History at the Ecole Forestière. In the examples of bad pruning a section made through the middle of the branch shewed frequently how, not only was a faulty piece of wood enveloped in sound timber, but also how the stump of the branch left had served as a canal to convey rottenness into the heart of the tree, and thus spoil the growth of years. Even when the operation had been skilfully performed, there always remained a clear solution of continuity (generally represented by a line of darker colour than the rest of the wood), shewing how the successive yearly growths had approached nearer and nearer to each other on the cut surface, until they met in or near the centre.

* *Remark.*—A more practical method is to cut first a little from below, and then from above, so that both cuts meet.—THE EDITOR.

The oak suffers perhaps more than any other tree from the lopping of its branches, which is almost certain, unless very skilfully performed, to render it hollow. All the oak trees (*Quercus incana*) in the Ranee Khet Forests have been constantly lopped by the villagers, in order to procure wood for their ploughs. The consequence is, that there probably is not a sound oak of any size in the whole of these forests, and I doubt not that the same would apply to the oak forests of other localities.

From the above it will be seen that, if we undertake to prune our forests, we must train men especially for it, and not entrust this important operation to the first comer. This is evidently a very serious objection, especially in India. Moreover, the area of our Indian forests is so large as to render it extremely doubtful whether this plan is practicable.

We shall do well, therefore, to consider whether pruning is necessary, or whether it cannot be dispensed with altogether.

Now, branches cannot live without leaves, and leaves cannot live without a sufficient quantity of light, the necessary quantity varying with the different species of tree. It is therefore worth considering, whether by keeping our trees thick enough together we cannot kill off the lower branches while they are still small, and when their disappearance will leave scarcely a scar behind. If we can do this we shall evidently obtain a tall and clean stem, and without a fault in the timber. Moreover, here the control remains with a forest officer and not with a subordinate, whereas it is impossible that the forest officer should himself prune every tree, or even be there to superintend its pruning. He could however on the other system designate what trees might be removed in the thinnings, so as to allow of the proper growth of the remaining trees without endangering the "natural pruning" by the admission of such a quantity of light, as to cause the persistence of lower branches.

Now, it is found in practice that this method can be carried out most successfully, though not always *in perfection*, by *merely* keeping the trees close together, for the shade given by some species of trees is not sufficient to kill off their lower branches. The oak (*Quercus pedunculata* and *robur*) is a case in point. In a forest composed solely of oaks, although by growing them thickly

together the length of stem would no doubt be improved, yet oaks grown in this manner cannot be compared for length of stem (which means quantity of serviceable timber) and straightness of fibre with oaks which have been reared in a forest mixed with beech or with hornbeam, both of which have a dense shade. I have seen oaks (*Quercus pedunculata* and *robur*) reared in this manner *without pruning*, which had stems at least 60 feet high without a branch, the whole of sound wood of first class quality, and 4 feet or more in diameter. I imagine that most people will allow that it is not usual to see either (*Quercus pedunculata* or *robur*) reared on other principles than the foregoing, and without pruning having a stem of more than thirty feet without a branch. It seems to me, therefore, that a system which can point to such results is one which we may safely adopt, especially when we consider that it is free from the danger of bad execution, which is almost inseparable from pruning, and that moreover it is much more easily applied to large areas, such as we have to deal with in India.

Of course in the case of isolated trees or in mixed coppice, where the standards are periodically left with their stems exposed, it will always be necessary to have recourse to pruning, and if the precautions recommended above are attended to, good results will probably be obtained; but in my opinion pruning should not be resorted to, even for plantations, where either the species of tree planted has a sufficiently dense shade, or where a sufficient shade can be obtained by the admixture of some other tree.

Pruning badly performed is worse than useless, and even when well performed it is inferior in its results to, and more difficult of application than, the other method here advocated.

Note on the Dehra Doon.

By B. H. Baden-Powell,

Officiating Inspector-General of Forests.

On my way down to Calcutta, I visited Dehra Doon for the purpose of seeing Captain Bailey. Having only a few days to spare, I could not, as I should have liked to, make a regular tour through these interesting forests, but I went out to the Lucheewála sâl forests (Nagsidh hill and spurs) and through the Lucheewála forest and up into the Bulawalah forests (sâl) on the north

slope of the Siwaliks. Afterwards I went through some of the lower forests between the Siwaliks and the Himalaya, and returned to Dehra. I visited afterwards a forest above Shorepoke with a view to getting on a height and seeing the general appearance of the Siwaliks. The Lucheewála forest exhibits a still dense forest of sâl. Here and there stumps of large size and trees of considerable girth showed that formerly timber of good size was produced on the ground now occupied by tall thin trees from 18 inches and under to 4 feet in girth. The feature of the forest is dense and uniform growth of trees with an under-growth of not very dense grass, very numerous seedlings of sâl, and in many places seedlings of a leguminous creeper (name unknown). Many of the trees also suffered from this creeper, the tall slender trees being weighed down, and the stems cut into by the pressure of the coiling stems. The maljam creeper (*Bauhinia sp.*) also covered many trees with a similar effect.

In the Lucheewála forest the trees generally exhibited a twisted or rather crooked stem covered with numerous knots and swellings, from which multitudes of small sprouts sprung. At the base, the stem always exhibited an unhealthy swelling.

All the stumps and larger trees were distorted and hollow from fire. The *Xylocopus* attacks dead but not living sâl. Occasionally one comes upon grassy tracts of greater or less extent in the midst of the sâl forest. These may be due to depressions in which water collects, and in that case they are full of a reedy, sedgy kind of grass, and we do not expect them to fill up with sâl trees; such blanks could only be filled by willow cuttings were it important to fill them; but it is not; the area of sâl is abundant, and such small blanks may be disregarded. Other blanks are on level ground, apparently of the same soil and quality as the rest of the forest. These are perhaps due to old and abandoned cultivation, and indeed the name of one of these blanks which I examined in Lucheewála Jabrkhet seems to lend support to the view. The effect of protection is, that the sâl seedlings are growing up under the edge of the forest, and filling up the blanks; even towards the centre a careful search shows a few seedlings of sâl and some of other trees. The grass is not as a rule dense; the "neel" and "moong" grasses (*Imperata* and *Sacha-*

rum spp.), which grow from dense tufts or masses, do not appear, and the grass is of such an "open and divided" character, that you can see the soil through, and therefore it presents no serious obstacle to natural seedlings coming up through it, or when necessary, seed *dibbled* in coming up in the same way.

I examined the soil in the Jabrkhet, and found it a rich colored brown loam, with a tendency to be stiff on the surface if exposed, and capable of producing with the aid of dead leaves and *humus* of the protected forest a very rich and valuable forest soil. No boulders appear, and I have no reason to doubt by the aid of what ravines and cuttings show that there is a good, though probably variable depth of soil over the boulder and drift strata below. *The soil inside the forest was similar, and it was quite cool and* moist at a depth of 2 feet.

The sâl developes a long and thick tap root, which remains to a considerable age. Even a year old seedling had a very strong root, and a seedling, about 2 feet high, which proved on clogging to have been a shoot from a small stock (4 or 5 years old burnt down yearly), had a tap root 2 inches in girth at the top and only gradually diminishing when I stopped digging at 2 feet down.

It is incredible how any one who has seen such a forest as Lucheewála can have the least doubt as to the frightful injury caused by fires, which not only prevent any thing like timber growth, but will, if unchecked, slowly, but still quicker than people think, exterminate the Shorea altogether.

In Lucheewála I think there are not 30 per cent. of trees which are not hopelessly injured for *timber* growth by the fire, or *creepers, or both.*

There is a small tract (350 acres) partly in Lucheewála and partly in Bulawalah preserved now for 2 years from fire. This time is hardly long enough to shew so marked a change that any one would perceive it, but it must be admitted that there is a difference already, and it will become more perceptible every year.

The peculiar shape of the sâl seed (like a shuttlecock) enables it to fall at some distance from the trees (it germinates almost before it falls), but its weight and size does not allow it to go very far.

Bulawalah has much better growth, less creepers, a larger percentage of small and comparatively uninjured clean straight stems, and altogether a better class of forest on the north slope of the Siwalik itself.

Now, in making any general proposals regarding the treatment of these forests, I wish to guard myself against being thought to jump empirically at conclusions from one day's wandering through a class of forests; but I am told that they represent very much the style of all the Siwalik forest—some being worse, and Bulawalah representing a fair sample of the *good* forest.

I may here remark that the Doon presents easy features for forest organization. It is a tract of undulating ground; alluvial soil over boulders and drift between the Hymalayan Ranges and the Siwalik. The Siwalik extends in a compact range, the northern side covered with sâl, which is rather dense about the middle and lower portions, and thinner towards the crest. On the south side are abrupt scarped sandstone faces, on the ledges and flatter portions of which Babba grass (*Eriophorum*) abounds, and mixed forest of various deciduous trees scanty and sparse.

In the Doon itself, besides the Siwalik, there are more or less detached hills and level forest patches. Such are Nag, Sidh, Ambari, &c. I have here sâl like the Siwalik.

The Doon is divided into Eastern and Western portions by the road from Saharunpore to Dehra, &c.

Below the Siwalik, on the north side, we come to Savannah forest, broken ground generally with boulders and pebbles, but still with much soil in places, covered with long grass and scattered trees of *Rottlera, Bombax, Adhwari, Acacia Elata, Ficus Glomerata,* and many others.

In the Eastern Doon, with the exception of certain grants, there is little cultivation, and we may describe the forest right across to the Himalaya. After the Savannah forest we come to the streams, on the banks of which we find khair (*Acacia Catechu*) and sisu, sometimes in pure forests tracts, while in other places, where there are numerous side channels and streams wandering about, we have dense grass, and often streams in deep shade, where luxuriant belts of trees of glossy foliage, mostly unknown to me, are crowded together, and the beautiful creeping

rattan (*Calamus sp.*) may be seen. About here also toon trees flourish; this extends right across, till sâl is again reached, and then the lower slopes of the Himalaya, which do not belong to us (except a small leased tract, in which some *sein* (*Pentaptera*) grows). In the Western Doon, the whole of the area beyond and indeed including the Savannah forest is either cultivated and is private property, so that generally speaking the forest boundary ends with the actual sâl forest at the foot of the Siwalik or of the semi-detatched sâl bearing hills.

It is reasonably supposed that the same class of lands in the Eastern Doon will also be granted out and cultivated.

As far, therefore, as the administration of the forests goes, there should be two "executive charges"—the Eastern and Western,—and the whole under one "controlling" or divisional charge.

There are no rights, properly so called, in the forests, so that it will be proper (subject to some arrangements to be noted presently) to make the forest area consist of the Siwalik and detached sâl forests, and for the rest I would not propose to include anything else but a few plots, not too small, say not less than 1,000 acres of just the best "khair" and "sisu" forests before spoken of, and especially those where "toon" is found or could be encouraged. The management of the southern slopes of Siwalik would be simple; their position is their safety; but it is important to protect the growth, for the sandstone is very soft, and contains nodules and masses of more indurated stone, and also belts of boulders and pebbles. The more it is denuded the more these will be washed down to the great damage of such works as the Mohan Pass road and bridges. I would simply prohibit, as far as possible, *all cutting*, only allowing individual trees to be rarely and occasionally taken for purely local needs.

Passing over the sâl on the north slopes (for the moment), the limited areas bearing "sisu," "khair," or toon only require *protecting*. If such small areas can be kept clear of fire, I have no doubt that they would become valuable; with fire they will never become better, but gradually worse than they are now. When leisure is found it will be easy by cutting out other growth near the toon to encourage its natural growth, and to dibble in seed.

Now for the sâl: these will require nothing but *protection* and creeper cutting. From therein fire MUST ABSOLUTELY be kept out and GRAZING. The latter for two reasons, because the seedlings will not grow up without losing their top shoots, getting trodden down, &c., &c., but above all because where there is grazing there is *fire*.

But if the Savannah forest, &c., is given up in the Eastern Doon, as it is in the Western, there will gradually be but little ground left for grazing. It will, therefore, be necessary to have certain blocks of the sâl forests—*not* taken out of forest charge, but left open to grazing, and as this forest is naturally divided for us into blocks by broad strong courses of torrents, &c., known as "raos," certain blocks between two "raos" may be left as open blocks for grazing only when local convenience prescribes.

As regards the idea that all the sâl forest may be opened to grazing, it is simply monstrous. If it is continued, it is a mere waste to spend money on surveys, working schemes, or officers; we may merely abandon the thing to the destruction which is inevitable, and leave it to yield what money it can (just as it did in old days) till it can yield no more. In short, the grazing must be disposed of in a rational manner, on a real enquiry as to the number of villages, houses, &c., to be provided for, and if possible, the number of cattle to be fed; and not, in general terms, without reservation or control.

Next then I have to consider what sort of a working scheme will be required, again repeating that my ideas refer to what I have *seen*, and must be considered by those familiar with the whole place, and modified as may be necessary.

For the "south face forests" no plan is needed: it is simply necessary to protect, as I already said. The place should be divided out into business-like and manageable *administrative* divisions, so that the forest guards and foresters may have their own proper 'ranges' and beats.

In the sâl forests the blocks will mostly be made by the "raos" or artificial broad lines, and these will be divided into compartments.

Ordinary compartments are dependent on the natural difference of growth, soil, young forest, or old forest, &c.; but here it seems

to me that the whole of the sâl is so similar as regards the features of treatment, that with the exception of constituting the grassy blanks (when of extent not less than 30 acres) as separate compartments, nearly all the rest may be divided into equal compartments.

The compartments need not *all* be fire traced, nor need they, I think, be very small; 200 acres would be suitable.

The reason for this explains also why I think that there is no need of a *valuation survey* at present.

It is that I regard the whole of the standing stock as one that will not, except a limited percentage of it, come to much, and it is to be regarded as a cover for the soil and to shed seed; it is to the young seedling crop that I look to make the forest; when that is well up all over, then all the present bad trees will be cut out as improvement cuttings, without regard to age, size, and cubic contents.

When the ground *is* covered with the new crop uniformly and fairly, and this is no improbable speculation, but almost a certainty *if fire* is excluded, it will be time to make a valuation survey for the purpose of showing us how many good and improving trees of the former stock we actually have, and how the young growth will come on for cutting, at different periods, so as to obviate the difficulty of having all our compartments of the same age and class.

With a view, however, to amassing the information for such a future proceeding, and for other purposes also, it is, in my opinion, essential to have, as suggested by Captain Bailey, numerous "Sample areas" of 10—20 acres in different parts of the forest, and as far as possible under different conditions; these must be carefully fenced, and perhaps the *aloe,* so common in the Doon, would be planted as an additional probation, and as an immediate and visible indication of the plot. It is worth at least a trial.

Valuation surveys of the areas should be taken at once, and yearly measurements with notes of selected trees of various sizes.

It will be a good thing to have some good ring-counting made of sections cut from trees now standing.

The actual treatment for compartments can be simply prescribed.

First is to keep out fire. Now from the positive evidence we have that the forests have produced big sâl trees of great value and may do so again, I think it justifiable in the highest degree to spend a good deal of money in thoroughly and efficiently cutting broad fire lines. The smaller the sub-division, the more easy it is to prevent fire, or to stop fire once begun from spreading, especially when a well-ordered establishment has charge of the places, rendered to some extent more accessible by the cleared lines,* supposing them to be kept but clear; but here arises a difficulty; how far can we sub-divide the area by fire lines? Not each compartment, for we should have to make and to keep up lines in miles by thousands; but we must do it to some extent, say to protect blocks of 2,000 acres at the outside as minimum of sub-division; and I believe that it will pay well to spend a good sum of money in making and keeping up the lines.

If we spend 10 to 15 thousand rupees a year, I would not object.

It is a pity not to take all the sâl we have, and it is *impossible simply*, as we are all agreed about that, to improve it on any other terms.

Then from the rest, we have at present not to cut a stick. Sâl *comes up under quite thick shade, and directly you let in light*, you have grass, and when grass is dense, seedlings do not come up, and you have the expense of artificially aiding the reproduction.

Whenever the ground is perfectly stocked, then carefully and gradually take out the bad poles of the present growth for sale: but at *present all the forest* is thin *enough* and *often more than thin* enough to allow of free germination, indeed, much of it is stocked already.

Also the plan will arrange that compartment by compartment *creepers are* to be thoroughly cut. This is essential.

In the blanks already described, I do not advocate nurseries or planting if protected by fire, as I have shown, all round the edges the reproduction is sufficient; just in the centre it may be necessary, I think, without *any* clearing of the grass or very slight in the worst places, to dibble in seed close together about the place. This

* I have here to make a suggestion. I find the patrols or guards do not go into the forest; they fear wild beasts, &c.; nor will they in Burmah. This is got over by fixing a forester's "range," but not the beat, simply giving a forester with one, two, or three guards under him, so that two or three may patrol together.

will certainly almost raise a lot of seedlings, and then after a year or more's experience, it will be easily seen whether just the centre formation will need to be either left alone, or out of desire for workman-like finish be planted up or sown a little more elaborately. That is all the plan that I think is wanted, but the order of cutting creepers and planting, &c., by compartments, will be laid down, to secure a fair apportionment of the work over several years, progressing from area to area.

In the khair and sisu forest, there is to be very little, or better no cutting for several years. I do not like the system of letting people pick out all the best khair stems for sugarcane rollers, &c.; and if they cut them, the permit should compel them to leave the *stump* close to the ground, but not *dug* out or hollowed, and clean to coppice. Where toon grows, I would encourage it by cutting away the other trees and weeds, and loosing the soil near the parent tree just when the seed is almost ripe; it will fall and spring up of itself. Further steps it is here unnecessary to indicate.

Mysore Sandalwood.

The following extract of a letter from the Conservator of Mysore Forests, to the Secretary to the Chief Commissioner of Mysore and Coorg, in Public Works Department, Rev.-Forests, No. 1861, *dated Bangalore,* 16*th September* 1873, *will be found interesting.*

*   *   *   *   *   *   *

The immediate object of my visit was to try and ascertain the reason of the rise during the past two years in the selling rates of our sandalwood, and whether the market in Bombay was steady, or whether the rise was owing simply to speculation. I therefore made myself acquainted with the operations of the chief importers and exporters of sandalwood, and found, as had for some time been suspected by the Officers of the Department, that the import trade is almost entirely in the hands of a few dealers. There are four of these men, two of whom, Háji Rámtulla Sét, and Háji Mitta Kásim Sét, buy direct from us. The names of the two others, Háji Abdul Raimàn Bármam and Kessao Purushóttamam, have not appeared in any of our account sales,

but they employ a number of agents at different times, and I found that three of our principal buyers here are actually agents for Kessao Purushóttamam; while a man named Alerika Ghulám Husén Sét, who has lately bought much wood, is only an agent for Háji Rámtulla Sét, mentioned above. Kessao Purushóttamam is also said to deal to some extent with a man named Abdul Khádar, who holds a monopoly of purchase of sandalwood from the Madras Forest Department for a term of three years.

The chief exports are made by seven firms, and Kessao Purushóttamam has also of late commenced exporting sandalwood. Though the number of men interested in the trade is not large, still there are sufficient to insure competition, which might possibly be extended with advantage to Government.

The sea-borne exports for the six years, regarding which I was able to obtain complete information, were in round numbers 2,300 tons, or a little over 380 tons a year. Taking this last figure as the average, and including the four incomplete years, we get a total export by sea of 3,720 tons out of an import of 6,050 tons, which figure is obtained by taking 605 tons as the average, and crediting that quantity to the incomplete year 1867-68.* Almost the whole of the export by sea goes to China and Arabia, small quantities only going by native craft up the coast. Wood of the first three classes goes almost entirely to China, while what is called *Jajpókal* (hollow billets) and *Bagar addad* (without number, or the small broken pieces, which are not included in the five classes of billet wood) go to Arabia, where it is either burnt whole for the sake of the fragrant smell arising from it, or ground up, or powdered and used with other ingredients as an incense. Much of the wood which goes to China is used in the making up of fancy carved articles, as incense in spells, and burnt in dwelling houses and joss houses.

There is in Bombay a fair local demand for wood of the better classes for the manufacture of carved fancy boxes, &c., and wood for these purposes is also sent to Surat. The inferior descriptions of billets are burnt by the Pársís in their fire temples, and are also used at Hindú funerals when the friends of the

* In 1866-67, we sold no sandalwood in Nagar, but in 1867-68 sold a very large quantity. The average may therefore stand.

deceased are able to afford it. For these purposes much wood is sent by carts up-country to various places in the Presidency. The wood rubbed down with water and worked into a paste is used by all Hindús in their caste marks, and is also used as an external application for headaches, and some skin diseases.

While in Bombay, I came across two funeral processions, and in both instances I saw billets of sandalwood being carried along to be added to the piles on which the bodies were to be burnt. While travelling to Surat by rail I met two Pársí priests, who got out at a small road side-station, and who had with them about half a maund of 5th class wood, which they were about to use in some religious ceremony. Much must be consumed in this manner.

The greater part of the wood leaving Bombay by land is sent by road on carts. The merchants told me that they do not use the railways much, owing to losses in transit, as well as the fact that carts do the work cheaper. The wood is of all shapes and sizes, and cannot, except at heavy expense, be put up in boxes or packets. It is therefore sent loose. If sent by cart, the cart-man is directly responsible for the number of pieces throughout the whole journey, and as he gets but a portion of his hire in advance, the merchant has a hold over him.

Of roots we sell about 115 tons per annum. As I have already stated, the greater portion of these do not reach the Bombay market, but are used up at Mangalore and along the Malabar Coast. About a ton of saw dust sold by us annually is re-sold in small quantities *en route,* and seldom goes to Bombay.

The stock of wood in Bombay at present is small. It is scattered over the town, but I think the total quantity falls far short of one hundred tons altogether, excluding small chips and shavings, for which there is at present but a small demand. These are being sold at the same price and in some instances at even less than what was paid us in Mysore. But chips after all form but a small item in the *value* of the wood sold, and the poor market for them is not likely to affect our sales of all other classes or the merchants' profit to any appreciable extent.

In Mysore we sort sandalwood billets in five classes, a sixth is made up of hollow bad billets (or Jajpókal); roots form

a class by themselves, and a seventh class is called Bagar addad, already explained. In the Bombay market this classification is not accurately observed. The first three classes are lumped together for export, while 4th and 5th are mixed with the best of the Bagar addad, which is often sound wood, though small. Jaj and Bagar are also mixed.

Taking our average rates in all our Kótís for the last two years (the years during which the market has chiefly risen), I find we sold wood sent to Bombay at the following rates per ton :—Classes 1 to 3, Rs. 432. Classes 4 to 5, Rs. 344. Jajpókal and Bagar addad, Rs. 368.

Classes 1 to 3 go to the China market, and the selling price in China is now 22½ dollars per picul. Seventeen piculs go to the ton, and taking the dollars at Rs. 2, this gives Rs. 765 per ton. The cost of carriage from our stores to Bombay, excluding agents' commission, is Rs. 60 per ton. The freight from Bombay to China Rs. 30 per ton. Allowing Rs. 10 per ton for agents' charges in China, loss of weight, petty thefts, loss of interest, &c., the merchant will have paid Rs. 532 by the time his ton of sandalwood reaches China; thus clearing Rs. 233 per ton, or nearly 44 per cent., which after deduction of 2½ per cent. (the ordinary commission paid to the Mysore agents), leaves a profit of nearly 41½ per cent.

I could not get trustworthy information regarding the prices in the Arabian market, but in Bombay, 4th and 5th are now selling at Rs. 540 per ton, and Jaj and Bagar, which go chiefly to Arabia, at Rs. 600 per ton. The merchant who sells these classes in Bombay spends Rs. 60 in getting his wood there, and allowing for agents' charges, he makes on 4th and 5th over 33 per cent., and for Jaj and Bagar addad over 38 per cent. The trade is not burdened with any import or export duty at Bombay or elsewhere in Western British India, nor with any municipal duty in Bombay or Mysore.

Though our minute classification is not adhered to in Bombay, it is of undoubted use to the merchant; and if we were to alter it, and mix the classes ourselves, I think we would not get the same rates. A certain Frámji Pestonj offered me Rs. 800 per ton for as much of *our first class* wood as I could

supply, delivered at Bombay. I told him I could not undertake to send up any, but his request shews that our classification is known, and occasionally used in smaller transactions.

From the roots oil is distilled; the process is carried on chiefly at Mangalore. I made enquiries in Bombay regarding this industry, and believe the information given to be accurate. According to this, five cwt. (one kandi) of roots yield 40 seers of pure oil at 26 tolas to the seer. This oil sells in Mangalore at Rs. 112-8-0 per kandi of 25 seers, which gives Rs. 180 for the 40 seers, the yield of 5 cwt. of wood. Our average selling price of roots for the last two years has been Rs. 352 per ton, and allowing Rs. 30 per ton carriage to Mangalore, the sale of oil at that place gives a handsome profit.

Selling price of 160 seers of oil at 4-8-0 per seer		Rs.	720
Cost of one ton of roots at Mangalore	382		
Cost of distilling oil per 160 seers	144	„	526
Profit per ton		Rs.	194

Which is nearly 37 per cent.

The rise in the Bombay market is alleged to be due to the rise in the price in China owing to a larger demand, and the rates have been steadily rising for the past two years. There is also a larger demand in Bombay, and the presidency itself, for sandalwood of all kinds, and I have already reported that the stock of good wood lying in Bombay is small. Since my return from Bombay I have received tenders, all at higher rates than tenders made me a month or two before my visit. The last tender came in yesterday morning. These all indicate a brisk demand, the more so that the merchants are well aware that we have just now a large stock on hand in Mysore. The tenders I submit now are as follows :—

A. Háji Abdulla Háji Abu Bákar offers for :—

1st	Class at	688	per ton.	
2nd	„ „	660		
3rd	„ „	612	„	All wood of these five classes
4th	„ „	580	„	now in store at Seringapatam and
5th	„ „	540	„	Hunasúru in Ashtagram Division.

B. Háji Rámtulla Sét.

No. 1894, dated 19th September, Rámtulla offers.—

1st Class at 640 per ton.	Offers to take 125 tons of these classes at *any* of the stores in the Province.	1st Class Rs. 690
2nd " " 592 "		2nd " " 667
3rd " " 580 "		3rd " " 644
4th " " 536 "		4th " " 611
5th " " 532 "		5th " " 598

C. Imám Mahomed.

For all the wood of the first four classes which may be collected in the Nagar Division up to 31st July 1874 Rs. 600 per ton all round. Also offers, should this bid be topped by any other merchant, Rs. 2 per ton more than the highest bid so made.

D. Abu Sét.

3rd and 4th Classes at 600 per ton Roots and Jajpókal " 376 "	For all wood of these descriptions in Ashtagram Division.

E. Háji Rámtulla Sét offers for all roots and jajpókal that may be collected up to 31st March 1874, Rs. 420 per ton.

On the 31st July 1873 we held of good wood the following quantities in tons, with the exception of chips and powder:—

	Billets.	Roots.	Jaj.	Bagar.	Total.
Nagar.	83	38	21	4	146
Ashtagram.	70	127	160	7	364
Nandidroog.	0	10	4	1	15
	153	175	185	12	525

If the most favorable of these offers are accepted, we should realize by the 28th February 1874 about two and three quarter lakhs of rupees without the value of bagar addad powder, and chips to be sold.

I found the local retail rates at Surat to be as follows:—Fourth, fifth, and good jaj at Re. 1 per 4 to 5 seers, or *at the rate* of Rs. 800 and Rs. 640 per ton. Roots sold by retail at 6 seers the rupee, or at the rate of Rs. 533 per ton. The trade in Surat is almost entirely retail, and it supplies many of the surrounding villages, using up about 50 to 60 tons per annum. I found the sandal tree growing at Surat. It is said never to at-

tain the size of the Mysore tree, and all the indigenous wood shewn me in the market was small, very yellow, knotty, and decidedly inferior in fragrance to that of Mysore. It is sold separately from our wood, and fetches about two-thirds of the price.

All our sandalwood is called in the Bombay and Surat bazars "Malabar Sandal," with the exception of the large dealers, but few of the bazar men know that the greater portion of the wood they sold came from Mysore. I told them that Mysore was the chief source of supply, and that it was the best they could get : the reason of its being called "Malabar" was simply that it was shipped from that coast. I noticed that our English stamp marks are not planed off by the dealers, and in the retail shops may be seen little bundles of wood with the stamp left intact. It is only lately that we have commenced stamping our wood in this fashion, for the purpose of identifying it and checking theft in the Province. It may possibly add slightly to the value of the wood in the market.

In column 4 of my statement in appendix is given the quantity of wood imported from "foreign external ports." These ports include Goa and Mahé, which being on the western coast, very probably ship some of our wood to Bombay, but I was told that a small quantity of Australian sandalwood is occasionally imported. I tried to purchase a piece of Australian sandal in Bombay, but could find none. Balfour, in his "Timber trees of India," states that "in 1847 nearly 1,000 tons of the true (?) "sandalwood, procured chiefly from New Caledonia, the New "Hebrides, &c., were exported from Sydney to China, where it is "burnt with other incense in the temple. The sandalwood trade "in these islands gives employment to about six small vessels "belonging to Sydney for China; it realizes about £30 a ton." I have placed a note of interrogation after the word "true" in the above. If Balfour is right in stating that Sydney wood realizes in China £30 a ton, it must be much inferior to Mysore wood, which is selling at £76-10-0 per ton. From other sources of information I have reason to believe the wood is not indentical with ours. In another place Balfour states the "sandalwood tree of the Sandwich Islands has almost disappeared." If the supply of wood failed there lately, it may partially account for the brisker demand in China for our wood.

Hearing in Bombay that a French firm, M. M. E. Baudry & Co., wished to buy small wood for export to France, I called on them, and was told by Mr. Sylvestre that there was a demand for small wood and chips in France, for perfumery. I gave him all the information I could, and also told the native merchants of this new outlet, which might prove to be a good one. In a price list I saw some time ago, I noticed that sandalwood of good quality sells in London at £70 a ton, but the demand is very small.

* * * * * *

The impression left on my mind after my visit was, that the market is a certain one; that the rates may fluctuate slightly from time to time, but that if there is no war in China, the rates will remain much the same as at present, rising if any thing, as that country is more and more opened out; that the demand in the Bombay Presidency itself is steady now, and not likely to rise or fall much; that as long as the merchants can clear 25 per cent. our rates will alter but slightly; and that we should take advantage of the present rates, as I do not think our sales are likely to glut the market, and produce a fall next year. When however we commence collecting nothing but old roots and dry wood in Nagar and Hassan, we shall realize less, but simply because we shall not have as much billet wood on hand for the supply of the market. The higher rates which may fairly be expected from reduced quantities of the higher classes being offered will partly compensate for this.

Before closing this report I wish to draw attention to a remark made by Dr. Cleghorn at page 29, para. 17, of his Note on the Mysore Forest Progress Report for 1865-66. See Government of India Reprint No. 11 of Public Works Department Records. "The trade returns shew that the annual average "export of this wood (Sandalwood) from Madras sea ports amounts "in value to about two lakhs of rupees, and most of this is the "produce of Mysore." It would be interesting to ascertain what the export from the port of Madras is, as that would give us the quantity sold by the Madras Forest Department, and which is, I believe, the wood that goes to Calcutta.

Exports of Sandalwood from Mysore, and Imports and Exports of Sandalwood in Bombay from 1864-65 *to* 1872-73.

Year.	Mysore.		Bombay.							
	Exports.		Imports.				Exports.			
			From Foreign external ports.		From ports in other presidencies.		To Foreign external ports.		To ports in other Presidencies.	
1	2	3	4	5	6	7	8	9	10	11
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1864—65	423	1,78,651	14	570	741	2,91,611	...	...	...	...
1865—66	778	1,86,969	49	3,075	590	1,80,240	...	...	...	...
1866—67	321	1,03,178	66	4,401	493	1,76,931	165	70,902	$\frac{3}{10}$	59
1867—68	950	2,69,840	...	...	...	...	...	...	...	...
1868—69	691	2,83,524	1	453	608	2,30,906	406	1,82,044	107	33,640
1869—70	740	2,38,640	25	4,800	504	1,82,166	262	1,19,002	39	11,269
1870—71	715	2,30,511	9	2,612	585	2,05,693	338	1,95,752	49	12,363
1871—72	800	2,66,042	70	11,035	1,037	3,67,729	433	2,22,620	37	10,998
1872—73	714	2,76,410	$1\frac{1}{2}$	56	642	2,16,349	398	2,17,386	58	26,481
Totals...	6,132	20,33,765	$245\frac{1}{2}$	27,002	5,200	18,51,624	2,002	10,07,706	$290\frac{3}{20}$	94,810

The African Gum Copal Tree.

Report on "Niti Sandarusi," Copal Trees. By Captain F. Elton, 1st Assistant to Political Agent and Vice-Consul, Zanzibar.

It was difficult to arouse any interest in inquiries made at Dar-es-Salam with regard to the whereabouts of the modern copal tree. The Arabs assured me it was not worth taking the trouble to look at, and when we referred to the Banyans, who in this neighbourhood trade largely in Animé, they adopted a similar view of the inutility of taking any trouble in the matter, adding, with characteristic hankering after profit, "if the true Sandarusi could be dug nearer the coast, that would be a gain to us, but do not all know the tree copal is cheap stuff?"

Some maintained with persistency that there were no such trees now standing near here; "those seen by people before had long since been cut down; there were but few far inland;" and others seriously attempted to convince us that the existence of the "Niti Sandarusi" was questionable.

In fact, I failed altogether to elicit any information or excite any sympathy on this interesting subject amongst the more civilised portion of the community, so turned to the slave population, and instituted an enquiry on the Seyyids' plantation outside the town. Here I soon discovered, not only that several isolated trees and small groups existed within reach, but also that the slaves employed in clearing land had arrived at an extensive belt of them, where the India-rubber Uiana was also abundantly found, and which spread for a considerable distance inland.

On the 16th I left Dar-es-Salam in company with Lieutenant T. F. Pullen, Her Majesty's *S. Shearwater*, and we proceeded with a guide in a westerly direction by narrow winding paths through broad fields of "Mhogo" and long well-tended rows of cocoanuts for some two miles, until we reached a "clearing" of the customary east coast description. Charred stumps of trees and felled and blackened trunks entangled with the tough half-burned ropes of the India-rubber climber strewed the ground and obstructed rapid progress over the ankle deep layers of wood ashes and treacherous "stubbing" holes on the one side, as far as the long "straw" grass and thick brushwood bordering the cultivated lands, and in the other direction up to the outskirts of a dense African forest stretching far away towards the Marni Hills and Uzaramo.

Past this clearing we found slaves busily at work hacking down trees recklessly, and from amongst these people our guide chose two slaves, one a Miao and the other a Muinde, who led the way over the wrecks of some hundreds of fallen trunks until we at last reached the borders of the wood and found ourselves amongst the "Niti Sandarusi."

We were not long in endorsing Dr. Kirk's report published in the Linnæan Society's Journal (Botany Vol. XI, paper on Copal of Zanzibar and the "*Trachylobium Mozambicense*"), for both of us were astonished at the immense number and size of these trees, far exceeding anything we had before imagined. Here almost every tree around us represented the striking characteristics which will be easily noted by the annexed sketch, and the following carefully measured dimensions, which may be taken as represent-

ing an average tree, but by no means one of the largest of the group :—

					Ft.	In.
Height (top branches lopped off)		...	...		60	0
Girth at ground ...	...	...	...		4	3
,, at 5 feet above ground ...		...	...		3	2
Height to 1st branch	...	...	...		21	6
Girth at ,, ...	...	...	...		2	10

The trunk, which is covered with a moderately thick bark, 3-16th of an inch, resembling that of the Birch, grows perpendicularly in the larger proportion of trees to a height of about 20 to 25 feet. At this point the main limbs fork out, and from the extremities of the branches the foliage spreads into that flat-crowned appearance so common to many African trees. The fruit is of a brown color and an irregular almond shape, studded with small excrescences, the leaves glossy and of a vivid green, as the specimens forwarded will show.

On stripping off the bark we found the gum deposited in many places, between it and the wood, in a liquid form. This was also observable to a greater extent when sawing off sections of branches; where the tree was injured a resinous gum had collected in considerable quantities, and was also seen on several trees on the lower sides of the branches; on the upper sides none was seen.

The Muinde climbed up and stripped off several specimens with a knife, but none of these run to a large size. The larger pieces, we were told, are found at the foot of the tree where, falling, they become buried in the sand. The Miao told us his wife received a dollar altogether for what she had dug at the foot of the tree in the sketch, a rotten branch of which had fallen.

Marks of digging were observed in all the surrounding soil; however I am not inclined to think the gum falls in a liquid state, for no extensive deposit is noticed except where a state of decay exists; hence it is probable that where trees have been left to fall to pieces from sheer old age, large quantities may with reason be expected to be found buried and to have survived all traces of the tree itself on the ancient site.

Insects innumerable live on the Niti Sandarusi. One branch was cut down in which a family of ants had formed a large nest behind a wall of the gum, and were rapidly undermining the heart of the wood. Between the bark and the wood, on stripping the former covering, legions of ants and wood-lice were seen, and a small green lizard with a yellow head, striped longitudinally with black lines, was pointed out to us as peculiar to the tree.

Indeed one can readily understand that it must be a mere question of sufficient time to produce gum which must necessarily contain imbedded specimens of the various insects common to the Sandarusi, and in a half decayed tree one would expect to meet with many such evidences of the former inhabitants, but not with the leaves or fruit, which are only found growing, as I before noted, at the extremities of the branches and remote from the situations in which the gradual formation of the copal commences.

The conclusion, then, which both Lieutenant Pullen and myself arrived at is, that the attacks of the swarms of ants and other insects lead invariably to the slow but sure destruction of these trees, piece after piece, branch after branch; as the heart of the wood becomes undermined, the tree throws out the resinous gum in considerable quantities; almost it would seem in an effort to arrest the process of decay, which occasions finally its fall, after which but a few years would be necessary to bury the wreck in the shifting sand which covers the surface of the sienna-colored sub-soil rich in vegetable remains in which the copal tree is found.

Almost all these trees were festooned with the long intertwined ropes of the India-rubber Uiana, the thickly matted cords of which pendant from the main limbs and knotted into a sort of rigging become an easy means of ascent to the natives looking for the resinous deposits on the branches. This India-rubber was worked rather extensively here at one time, but was soon given up as unprofitable in consequence of the number of slave lads carried off by leopards; now, however, it does not appear to strike the Sultan's overseers that it would be more lucrative to collect it as they move on with the clearing, than to cut down and burn the Uiana by hundreds.

Our guides easily worked up two large balls of India-rubber for us. After making deep longitudinal incisions in the main ropes of the Uiana, the milky substances which exuded profusely they smeared on the fore part of the left arm. When enough had been procured, this was stripped off in flakes and rolled up in the hands until it assumed the shape of a small dumpling. At Dar-es-Salam this article of commerce commands a price of from $9 to $10 per frasilah of 35℔s. weight.

The slaves told us that you could travel for two days into the interior before losing the "Niti Sandarusi," and that during the whole of that distance the India-rubber was commonly parasitic to the trees. At the rate the clearing progresses, however, it will not be long before this copal tree-wood becomes a thing of the past.

At a second visit, when we worked along and into the wood, all we saw only confirmed the conclusion we had already come to; however, I trust, after inspecting the principal diggings, to be able to give a more detailed account of the situations in which the tree is found, and its relation to the fossil Animé.

ROYAL BOTANICAL GARDENS, CALCUTTA.

I have read with much interest Captain Elton's report on the African gum copal tree. I think he and Dr. Kirk are quite right in their conclusions of the origin of this gum.

It struck me much that this tree and also the caoutchouc climber *Landolphia sp.* might advantageously be introduced into Southern India (Malabar and Travancore), and also into Burma, where they would flourish in the laterite grounds if not too rocky. The stunted growth of the Zanzibar forests points to physical relations similar to those existing in the British Burmese forests. It would be really a great gain if also the ripe fruits of the African caoutchouc climber could be obtained for trial. I have retained also several fruits of the copal tree for sowing. These contain apparently quite sound seeds, and I have good hope that they will come up. If so, it might be arranged to send some of the young plants to Burma and Southern India, for I fear they will not succeed well in Calcutta.

S. KURZ.

From 1st Assistant Political Agent and Vice-Consul to Her Majesty's Acting Political Agent and Consul-General, Zanzibar.

EXTRACT.

Our day's journey, which I estimate at 19 miles, lay through a gently undulating grass country, with extensive belts of fine trees (amongst which the "Mti Sandarusi" was frequently to be seen), stretching away to the foot of the hills marking the Uzeramo country, and only broken here and there by a gentle rise, or an outlaying "Shamba," with its surrounding clearings and "Mohogo" field.

Everywhere signs of copal diggings were visible. In fact, we were passing through the main fields from which the Zanzibar market was once almost entirely supplied, and which still produce this valuable gum in considerable quantities.

The process of digging is a simple one. Twenty to thirty men, generally of the neighbouring tribes or free men, form a party and spread over a stretch of country, which they divide amongst themselves into clans, each of which is worked by five or six of their number. Operations are commenced in each instance by driving five holes° to the depth of about two feet as a prospect. If the yield is encouraging, four more holes × are driven, which are followed by the levelling of the whole square to the orthodox depth of about three feet, deeper than which no shafts are sunk. One square being worked out, a new one is commenced and prospected in precisely a similar manner, until all likely ground is gone over; purely sandy soil without a sub-stratum of fibrous and decaying vegetable remains being passed by. The salemen, chosen from their knowledge of the coast trade and villages, then effect a sale, for which they receive an increased share over and above the rest of the workers, and after the division of profits all knock off work until compelled by want of money, *i.e.*, goods, to take to the fields again. The trading generally takes place at night in the house of the Indians (whose principal business is copal dealing), and should no bargain be arrived at, the Washenzi leave before daylight, sleep in the woods, and return again at dusk to resume negotiations. As the gum is brought in, it is an admixture of

0	×	0
×	0	×
0	×	0

the tree, the chakazi, and the true (so called fossil) copal, and, I fancy, is still further doctored on its way reaching European merchants.

From 1st Assistant to the Political Agent and Vice-Consul, Zanzibar, to Acting Political Agent and Consul-General, Zanzibar.

The "Msandarusi," or copal tree, is largely scattered over the extensive tract of country stretching from the Marui hills and the Uzeramo, through the rich district of Kwale, away to the Matumbwi range of mountains on the south-east of the Rufiji River, and lies within the limits which are bounded to the east by the sea-coast line of cultivation and settlement, and to the west by the highlands which form an irregular barrier to the Mrima at a distance of from 30 to 35 miles inland. Throughout these limits immense quantities of the semi-fossil "animi" are dug by the natives, and this produce constitutes the most lucrative commerce of the Indian settlers at the small trading ports.

Farther south, beyond the Samanga villages, there is a break in the supply, probably occasioned by the surrounding slave traffic, which rapidly drives legitimate business and all confidence out of its path, but also affected to some degree by the increased difficulties of communication caused by the marshy swamps, which here fringe the coast more deeply than above the Rufiji. However, beyond Kilwa, copal again re-appears, and is largely bought up in tranquil times at the numerous trading stations which dot the sea-board down to the Rovuma River.

The "old working," close to the village of Massonga on the Kisiju road, from which many ships' cargoes of "animi" have been extracted, appear to be now almost exhausted, for although small parties re-work the ground occasionally, it is neglected by the men, who habitually supply the Indians, for a tract of land bordering on the same road, a little further to the south, and situated in the district of Mangatani. In this country a forest, called the "Kiregesi," contains many "Msandarusi," and between the belts of these trees and in the broad transverse glades, which always intersect African woodlands, some of the finest fossil gum is dug. This never reaches the trader, however,

without a large admixture of the copal from the neighbouring trees, and the contents of the digger's basket are made up with *wet sand and small stones, in order to gain a little extra weight,* it being war to the knife over the barter of "animi" between the Indian and the Washenzi, a contest in which both sides are equally unscrupulous.

Dar-es-Salam is only sparingly supplied with the gum, the trade being diverted to Mgogoni, Tuliani, &c., but the immediate vicinity furnishes this part of the coast with ease, and at Mangatani the agents of the Banyans buy for Kisiju, Bosa, &c.

The extent of the produce is not fully realized until the Kwale District is entered. Here are found the following stations where the trade is carried on systematically :— Kitmangao, Zerare, Nusseebgani, Kunderani, Demuni, Makrora, Kivinja, Sandazi, Mji-Mema, Pemba, and Kikunia, all of which are almost solely occupied in this one commerce. In the early morning strings of natives are seen on the paths, each party led by a few men armed with old muskets and bows and arrows, and consisting of women and lads, carrying copal baskets, and except during the very dry season, these arrivals take place daily, yet, even here there is no organized system of working; "prospects" and shafts are seen almost everywhere, but a regular supply cannot be *insured, no pressure can* induce an increase when enough gum has been bartered to satisfy the present demands of the petty Chiefs. Neither do the Indians venture to send out parties of their own, each village and each working is represented by a headman or "Jumbe," and the natives are only too ready to unite against the slightest encroachment on their monopoly, the "trade union" system being here represented in its strongest form.

However, during the rains there is not much slackness, the ground being soft and easier to work with the rough hoes and pointed sticks used to clear out the holes; below 4 feet no fossil gum is found worth taking, and indeed very few diggers appear to go beyond 3 feet in search of it; but all is grist that comes to the mill, copal from the tree, the copal dug beneath the branches, fossil copal, and the decayed gum, and the difficulty of arriving at any fair valuation of a quantity must in consequence be great.

My opportunities of visiting both diggings and trees in this district were frequent, and it is from here that the specimens forwarded were collected, as also the fruit, which the natives state to be fit for planting; and I find no reason to induce me to alter any points in my former report on the "Msandarusi."

Sandazi boasts of a giant copal tree, which overshadows the main street of the village, and is superior in size to any others I met with; but even this really noble specimen is often excelled, I was assured by the natives, by trees found nearer the hills. At Kikunia a brisk trade flourishes in the gum with the Rufiji tribes and the Mtoti. Past the Mpenbeno Ferries on the Rufiji, and skirting the plains which stretch to the Mutumbwi Mountains, Mohoro is reached (a village on the river of that name, which enters the sea at Pemba-Utagiti, but does not belong to the Rufiji-Delta), and both here and at Furu, Murdengo, Kuajo, and Samanaga, and at an inland station called Chabwani, the principal business is copal.

Beyond the Samanga group of villages, the road towards Kilwa Kivinja passes through difficult mangrove swamps, and the country is thinly populated and very unhealthy. Kilwa reached, slave-trade and ivory monopolize all attention, and what little copal trade there is has dwindled down to small quantities brought in by the slaving expeditions, which venture a few days' journey from the town.

The district of Mungao is now in such a disturbed state that all trade is closed, except at Lindy and Mzinga, several natives having been killed whilst on their road to the settlements laden with the gum; but in peaceful years large quantities arrive from this part of the country at Zanzibar: Kwale and Delgado exported $40,000 worth so long ago as 1867-68, since which date, I believe, no correct returns of the southern trade have been kept.

The Indian trader on the Mrima has many extortions to fight against and heavy duties to pay, neither can his life be a very pleasant one, spent, as it is, in one continual succession of haggling and quarrelling with the natives, in competition with his neighbours, and a monotonous round of coast fever. The local Jumbe extracts a ground rent from him, and he is fortunate, if

only one claimant to territorial dues appears on the scene! The Jumbe is followed by the Jemadar, who levies an arbitrary percentage on his supposed profits, and besides estimates the amount himself in order to save discussion. The Custom House then abstracts 20 frasilahs from every 100 frasilahs of copal shipped as the Government duty, and, in addition, charge him on expenses, storage, and delay. Add to all this, freight and interest on money, and a considerable addition is made to cost price.

Three to as high as $5\frac{1}{4}$ Dollars are the Kwale estimated cost of the barter per frasilah of copal from the Washenzi, prices varying according to the season of the year, and the number of the men of the various tribes at work, demand, &c., and at Zanzibar the merchants buy at from \$7 to 8, according to their written agreements with the Coast Agent.

Against all difficulties the trade undoubtedly prospers, and affords large gains to all concerned, whilst it is clear the apparently inexhaustible supply of copal, under a settled rule and with systematic working, would furnish the means of supporting a far larger community than that now sparsely scattered along the Coast.

The tree would appear to have lined the shores in old days, but the extent of the ancient forests can now only be estimated by the area of the present workings and by the position of the existing "Msandarusi," which are found away to the foot of the low hills bordering the Mrima and on all the terraced lands sloping down from the ridges to the present sea beach. It seems also impossible to estimate the time required to effect the change of the tree gum into the so-called "fossil" animi, although all local evidence confirms the identity of the origin of these two articles of commerce, the difference in the value of which is so great.

Indian Forests.*

BY J. L. LAIRD.

This little pamphlet is a reprint of an article in the 1874 volume of "Aus dem Walde," a forest periodical edited by Dr. Burckhardt, Director of Forests in the province of Hanover, and is dedicated to Anglo-Indians who are familiar with the German systems of forestry.

The author has, from time to time, made the acquaintance of Indian forest officers travelling on the Continent, from whom he has obtained the information regarding Indian forests contained in the present essay.

After some general remarks on physical geography, the vertical distribution of forest species, and organization of the *personnel*, the writer describes the method of exploitation until lately in vogue, and the improvement which it is hoped to effect by gradually confining the cuttings to smaller areas.

As regards re-stocking, Dr. Burckhardt is of the opinion that Indian forests "should be regenerated by self-sown seed, and that only in exceptional cases artificial methods should be resorted to." We heartily agree with this opinion, and think that natural reproduction by mother trees, or something similar—such as planting under standards—should be tried on a small scale, and if successful, be introduced more generally. The financial advantage of natural regeneration is obvious. On the one hand, we have an immense expenditure for nurseries, planting, and watering; on the other, none. The question is: would this method succeed? Experiment alone can tell; but there is good reason to hope that, in parts of the country, it would. "Imitate Nature" is a favourite maxim with those who pride themselves on being practical, and in adopting the natural system we would be merely carrying out this principle. It is, moreover, at least reasonable to expect that, if trees in a forest left to itself reproduce themselves spontaneously *by seed*, a treatment almost identical would give almost similar results.

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* Aus dem indischen Walde, insbesondere über den Teak und Salbaum. Separatab, druck aus dem V Hefte "Aus dem Walde" vom Forstdirector Burckhardt, Hannover. 1874.

Dr. Burckhardt seems to be in favour of retaining the primitive method as a general rule, but of gradually concentrating the cuttings, and confining them strictly within certain limits for certain periods. We must confess that we cannot see much difference between this and natural regeneration; all that would have to be done would be to carry on "concentration" a little further perhaps. In any case, the character (trees of all ages mixed up together) of most of our forests would not admit of any sudden change, so that the degree of localization is not a matter of much importance for the present.

The object of confining operations to more limited areas is clearly shown. "Concentration facilitates regeneration; for the cuttings, being smaller, can be more easily inspected, and supervision is not relaxed until the young crop is fully established. But the reverse is the case when blanks are scattered over large areas; they are then easily lost sight of altogether, and cattle grazing is all that is wanting to cause the disappearance of any seedlings that may have sprung up. The result is incompletely stocked woods, so frequently seen in India; and it may be stated as a general rule, that the more extensive the cutting, the less complete the stock of young growth.

For the same reason the wood cut is more easily checked and guarded. Even the mode of transport may be affected, as roads pay only when large quantities of material have to be extracted."

Farther on we are reminded that wood loses as much as 80 per cent. of its weight and half of its volume by being converted into charcoal, and that where the transport of firewood does not pay that of charcoal might.

Special chapters are devoted to teak and sâl. The reason given to explain why unmixed woods of teak are unknown, *i.e.*, because this tree is exposed to more dangers than other forests trees, is, to say the least, very vague, and we think that a more satisfactory explanation might be found. Trees demanding much light—and teak is one of this class—cannot, except under very favourable circumstances, compete with trees preferring shade. Everyone knows that the oak, in spite of its more rapid growth, is seldom able to struggle unassisted against the beech; might we not

conclude, by analogy, that the same cause prevents the spread of teak, which is the representative in Indian forests of the oak in European forests?

Dr. Burckhardt recommends that small, unmixed clumps of teak should be grown in mixed woods, because "treatment and protection from suppression would be easier in the case of clumps than in that of isolated trees, and because lateral growth could be better regulated by thinnings."

He is decidedly averse to unmixed teak woods, on account of their open character, and the consequent exposure of the soil. In such forests, he recommends the adoption of Von Seebach's method, which consists in increasing the severity of the thinnings as soon as the trees have attained their full height, and at the same time raising, under the older growth, a second crop. The object being to accelerate the lateral growth of the standards by liberal thinnings, and at the same time preserve the moisture of the soil by means of the undergrowth. This method has been found to answer when large timber, or a sudden, but temporary, increase in the yield, was required.

The writer describes the means adopted by Dr. Brandis for estimating the annual yield. It is simply this:—The trees are divided into four classes, *viz.*:—

Trees from	0	to	12	inches in diameter,	or	IV	Class.
"	12	"	18	"	"	III	"
"	18	"	24	"	"	II	"
"	over 24 inches in diameter,				or	I	"

Having estimated roughly the number of trees in each class, by measuring the trees on a part of the area and then deducing from the data obtained the crop of the whole area, it remained to determine how many of the first class might be cut yearly, until those of the second class had grown into first class trees. The number of trees divided by the number of years required gave the annual yield. To find out the mean annual increase for each class, sample trees of average vigour were felled, the annual layers counted, and the diameters measured; the sum of the diameters divided by the number of rings then gave the mean yearly increase. Thus, if the mean annual increase of a forest were found to be ·1 of an inch for the second class, it would take 60 years for this

class to grow 6 inches, and our first class trees would have to last for that period.

Dr. Burckhardt thinks that the method of natural regeneration could be applied with advantage to the sâl. He tells us that it is frequently found in unmixed woods; that this fact, the lightness of its winged seeds, the ease with which it is propagated spontaneously, and the protection from running fires afforded by dense thickets, would warrant a trial of the method.

A perusal of this little book will well repay the trouble. The conclusions the author has arrived at are modestly stated; they appear to be well worth consideration, and are a proof—for the writer has never seen an Indian forest—that "the principles of forestry are everywhere the same."

(CHINESE BLACK-WOOD IN BOMBAY.)

WILL any correspondent in Bombay inform us what species of tree is indicated by the name Chinese Black-wood, and how seed of it can be obtained? Does it require a heavy rain-fall, or would it grow in North India? Any particulars of the experiments in Dharwar would be valuable.

B. H. B. P.

Fire Lines.

The work of burning fire protection *lines varies in different* places so much, that it is a good thing to collect different experiences from different quarters.

In the Dehra Doon the rain-fall is good, *but during the winter* and dry months the nature of the soil in the sâl forests, where there is very complete sub-soil drainage, causes the surface to become and remain very dry. It is remarkable *in this district*, how the *slightest* covering of grass will sustain a fire and allow a kind of smouldering, hardly visible combustion to creep along, till all of a sudden it reaches a mass *of material beyond, and* bursts forth in flames.

The following method of cutting fire lines in very inflammable localities, tried by Captain *Bailey, Deputy Conservator of Forests,*

seems worthy of record; it controls the fire by cutting the lines like a ladder.

I had lines burnt round 6 patches in the Boolawala and Lucheewala Forests, in the Eastern Dûn. The area of these patches was about 245 acres, and the length of line surrounding them was $6\frac{1}{2}$ miles.

I have satisfactorily determined that no unburnt line, on which there is any vegetation, is of the slightest use in stopping a fire.

I tried some experiments by cutting the grass as low as it was possible to cut it; but there was always sufficient left to carry on the flame, which passed rapidly over the line, rising several inches high.

I commenced to burn round the patches in the month of February. I found that in the early mornings the grass was so wet that it could not be made to burn at all.

After about two hours (9 A.M.) it seemed suddenly to have reached the burning state, and in a moment an enormous fire sprang up, which was with the greatest difficulty suppressed.

The flames rose so high, and the heat given out was so great, that the men could with difficulty be persuaded to go near it. After this I did not consider it safe to light the fire again that morning.

About 11 A.M. a strong breeze sprang up and continued all the evening, and it was impossible to light the fire again that day.

I however directed that during the day strips of grass about 6 feet wide should be close cut with a "durrântee" down each side of the line which I proposed to burn, and that the intervening grass should have cross paths cuts through it at every 50 yards. Thus the whole area was divided into small patches.

The next morning, as soon as the time arrived at which the grass would burn, I fired each of the patches so formed in succession.

A gang of 20 men stood round the burning patch, with green boughs to prevent the fire from spreading across the cut lines, and to put out any sparks which might be blown over them.

The greatest watchfulness was required, but the plan seemed to succeed.

The great advantage of this arrangement is, that the men can be usefully employed all day, and that within reasonable limits; it is as easy and as cheap to make a wide line as a narrow one, the

only increased labor for a wide line being the *extra length of the* cross paths or runnings of the ladder.

The plan recommended may be carried on with safety if a gang of 20 coolies under a sharp tyndale is employed; but I think the paths might be made 10′ wide if the grass be long and thick; and if it be very dense, the cross paths might be made at closer intervals than I have described.

The great object is to prevent the fire *getting too much* a head, and thus becoming beyond control.

The grass on the paths or strips should be cut as close as it is possible to cut it with a durrântee.

B. H. B. P.

Wood Ashes.

Coniferous trees, I find it noted in the *Revue des Eaux et Forêts*, give 3 times less ash than deciduous, and therefore require 3 times less of inorganic matter in the soil. Moreover, the leaves of pines are fleshy and persistent, which enables them to draw a larger amount of nourishment from the air. The roots in consequence have a more spreading nature and less tendency to go downwards vertically.

From the same journal I observe the following:—

10,000 parts oak give	...	250 parts ash.
,, lime (Tilia) give	...	600 ,,
,, fir ("Sapia") give	...	83 ,,

And for a general average it may be taken that woods give 2·5 per cent. of ash (other than conifers).

Supposing, then, 700,000,000 kilogrammes (1,540,000,000 lbs. nearly) to be annually consumed, the quantity of ashes would be 17,000,000 kilos (or nearly 38,000,000 lbs).

Now all this ash contains quantities of phosphates valuable to the soil. 100 kilos of the ash of beech will, according to Liebig, *contain 25 kilos of phosphates.*

M. DeL'arminet gives 12·2 as the percentage of phosphates generally.

The value, therefore, of most ashes as manure is enormous—where do they all go to?

B. H. B. P.

PINUS EXCELSA.

The following curious notice is extracted from Major Madden's well-known but not very accessible papers on the "Himalayan conifers" in the journal of the Agri-Horticultural Society of India. Have any of the correspondents observed any similar phenomenon, and can they give an explanation of it?

"During a fine dry winter, such as the present one of 1844-45, in the months of December and January, the leaves of the *kaeel* pine (*Pinus excelsa*) were completely covered by a sweet transparent liquid substance, which collected on the branches and leaves, and as it dried matted the latter as if with ghee. This substance concreted into a pure white manna of the consistency of honey or sugar, hanging down from the branches in the form of long or rounded 'tears.' In this state it is eaten by the hillmen, and is extremely sweet and palatable, without any flavor of turpentine. Abundance of it also falls to the ground, where it covered the stones with a coating as hard and transparent as the finest varnish; and the leafless branches of willows, &c., were quite enveloped by it, as with so much French polish. It was also produced on the cedar, oak, and *Audromena,* but far less copiously than on the *kaeel* pine. The mountaineers believe it falls from Heaven; to me it seems to exude from the leaves, but Captain Hay informs me that it was in fact secreted by a species of *aphis* of a dark brown color, about one-tenth of an inch in length, which was to be seen in multitudes on the branches. We learn from Burckhardt * that the manna of Mount Sinai, still called Manní by the Arabs, drops from the tarfa, a species of tamarisk, probably our 'fuvas,' only in years when copious rains have fallen, as last season at Simla."

B. H. B. P.

ON THE KILLING OF TREES.

It may not be generally known that in some parts of Burma the people have a very simple method of killing exogenous *trees* which *do not* succumb to the ordinary process of ringing or girdling, such as cutting into the heart wood and making a clear line of severance though the sapwood.

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* Travels in Syria, pp. 599–604.

The trees in question, which are of course those which have but little heart wood, or probably no real duramen at all, are ringed to the depth of several inches in the hot weather, and the incision there made is filled with moist earth or clay as soon as the rains sent in.

The first operation has apparently no effect whatever, and one is at a loss to comprehend why the ringing and application of clay should not be undertaken at one and the same time.

Undoubtedly the clay acts as a check to the anartomosis of the bark and sapwood over the incised part, and to this must be attributed the death of the tree.

It would be very interesting if any one well versed in structural and physiological botany would explain the actual effects in detail of the entire operation on trees of this description.

W. J. S.

On Transplanting.

The Government of India letter No. $\frac{14}{550}$ of 28th May 1874, circulating Mr. J. Ballantyne's report on the taproots of teak seedlings, has just reached me.

In Assam I consider it best not to transplant at all, but to put down the seed at what we call at stakes or on the spot it is to grow in, $3' \times 6'$, $4' \times 4'$, or $6' \times 6'$ distances.

Next to this, transplanting of small seedlings 2 to 3 inches high is considered far better than the transplanting of larger seedlings, in fact, the latter is never attempted. The same method of course could not be advocated in all the varieties of climate we have in India. *I hope residents in other parts of India will* let us know through the medium of our new forest paper what they consider the best, and how they manage.

G. M.

American Forests.

Constant and reckless destruction of our forests is fast bringing us to a condition in which there will be occasion for real alarm. It is not probable that any "scare" like that which a few years ago went over England, concerning the prospective exhaustion of her coal supply, will immediately occur in America, touching the loss of our forests; but we wish something near enough approaching it might happen, to stop a work that is full

of evil promise. In the whole of the United States there is left but one really great tract of timber. It lies at the far extreme of our country, and consists of about one-half of Washington territory and a third of Oregon. California has, perhaps, 500,000 acres of forest now, of which fully one-half has been cut away within the last two or three years. Here in New York we have no considerable forest left, except in the Adirondack region. Our wealth of maple, walnut, and hickory is substantially gone, and a large part of it has been wantonly destroyed. Wisconsin had a magnificent forest growth, but the people are sweeping it away at a marvellously rapid rate. One billion feet of timber was cut in a single year. It will not take more than a decade or two at the utmost to fairly exhaust this source of wealth to the State. Michigan and Minnesota are following in the same course, slashing away at their forests as if a tree had no right to lift its head. One of our most intelligent army officers, General Brisbin, who knows the western country thoroughly, and to whose accurate knowledge of this subject we are indebted for many facts, says that 50,000 acres of Wisconsin timber are cut annually to supply the Kansas and Nebraska markets alone. The Saginaw forests are even now practically destroyed, and if the Northern Pacific Railway is built, it will open up to the axe the one remaining belt of American timber, in Oregon and Washington territory. The railroads have been the great destroyers of our forests. They use 160,000,000 of ties annually—that means the levelling of at least 150,000 acres of trees. The timber they use, also, is not the refuse or the inferior, but among the very best, fine young trees, 8in. to 10in. in diameter. If it is remembered that ties have to be renewed every seven years, the extent of demand on our forests will be appreciated. When 10,000 miles more of rails have been laid, it will require all the young trees in the country to supply the demand for ties. Fences are also enormous consumers of trees. In the East we are learning in this regard economy from necessity, but in the West, in some States, the farmers cut down the forests with scarcely more thought than they harvest their grain. The fences of the United States, people may not generally know, have cost more than the lands, and are to-day the most valuable class of property, save

railroads and real estate in cities. Illinois alone has $2,000,000 invested in fences, and they cost annually $175,000 for repairs. In Nebraska, where excellent herd laws are in force, the necessity for fences has been so much lessened that the fences of the State cost less in proportion to population than in any other in the Union. The outrageous waste of timber caused by the felling of forests and burning of the trees to bring the land under cultivation goes on still at a fearful rate. From 1860 to 1870 no less than 12,000,000 acres of forest were thus wantonly destroyed. For fuel also vast tracts are levelled of their trees. It took 10,000 acres of forest to supply Chicago with fuel in one year—1871. Our annual decrease of forest from all these causes is not far from 8,000,000 acres. Yet we plant only 10,000 acres of new forests a year.—*New York Times.*

The Decrease of Water in Rivers and Springs.

The following data have been taken from a speech by Hofrath G. Wex at the Annual Meeting of the Geographical Society at Wienna on the 22nd January 1875.

Hofrath G. Wex stated that observations show a steady decrease of the quantity of water in rivers, and an increase of floods. Observations made show the following decrease during the last 50 years. On the river "Elbe" 17 inches; on the "Rhine" 24·8 inches; on the "Oder" 17 inches; on the "Weichsel" 26 inches; on the "Donau," near Orsowa, 55 inches. Corresponding with the above an increasing drying up of springs has been observed. If this was to go on, the German rivers would cease to be navigable, the smaller streams would dry up, the lives of plants and animals would be endangered, and by these means the existence of future generations would be threatened. The chief cause of these phenomena is stated to be the reduction of the area of land under forest, whereby not only a reduction of atmospheric deposits is caused, but also the falling rainwater rushes down the bare hill sides, causing temporary floods, whereas in land under forest the rainwater is retained as ground water, which feeds springs, thereby securing a steady flow of water in the rivers. Should not we here in India take a warning by such startling effects of forest devastation?

W. S.

IV. Shikar and Travel.

How I shot a tiger in a house.

"Sahib, bagh ka khubr aya." These words, so often heard, but never without a thrill of expectant pleasure, came from a chuprassie, almost as keen in the search of shikar as his master. I was sitting in my sanctum deep in one of those many reports which leave a district officer less time than of yore for shooting; but considering the protection of life and property of paramount importance, the report in this instance had to wait.

I soon heard the particulars.

A tiger in a village 10 miles off—but not merely in the village, in quiet possession of a dwelling house—a cow killed—a man mauled—could any khubr sound more promising?

The khubberier had come in hot-haste, taking some 2½ hours only on the road; the tiger was in the house when he started, and he was quite certain it would not dream of moving off until we had inspected it.

Quickly were the orders given for elephants, howda, and rifles to be got ready, and the following chit fired off to M., a right good fellow everyway, including proper love of shikar.

Dear M.,

Khubr! Tiger in a house waiting to be shot. Will you come?

Yours.

Back sped the answer "all right."

It was now 10 A.M., and alas all the elephants were out for charra. Could we expect them up in time to find the tiger still in the house, or even in the village? It seemed most doubtful. Close to this village, too, is very heavy jungle, where M. and I only the week before shot a tigress; but then we had a kill in the jungle as basis of our operations, or rather four kills, as four cows out of a herd had been killed and carried into the jungle and without a kill in such jungle you might as well look for the traditional needle in the haystack of our childhood as for a tiger.

Expedition was everything, so I galloped off to our Police lines, some two miles distant, and ordered out sowars to hunt up

the elephants, with instructions to the mahouts to proceed direct to the village without coming in for our howdas, which we sent on carts to a musjid a couple of miles out, a point where the elephants could pick them up without having to go out of their way.

It was after midday when M. and I started; a sharp canter of some four miles over a road which would have been good had those three letters of the alphabet P. W. D. never been placed in such close relationship to each other, brought us up with the elephants. Two howdas, four beaters, not a big line, but enough for our purpose.

It was no good our going on before the elephants. So for the last five miles or so we went leisurely along, speculating every now and then as to the possibility, almost rather the improbability, of our finding stripes still in possession.

It was a very pleasant ride, a bright cool day in February last, agreeable climate, good green turf to ride on, a tiger waiting for us, and not least, though last named, as companion a friend who had shared with me many a previous day's sports. Could any ride be more pleasant? Dear reader, do you recall those pleasant rides down the velvety turf-clad lands of dear old England, when your companion was perchance one of the fair sex, and think you could have rides infinitely more pleasant than that I describe? Of course you can, but you may believe me that these rides out to our "happy shooting ground" cement old friendship and live pleasantly in our memory long after the shooting days are past.

About the tenth mile we reached the camping ground on the J. nuddy. Here we were met by some of the excited villagers, with the assurance, almost too good to be true, that the tiger was still in the village.

We now got into our howdas. Mine was on Maula Bux, a grand makna, on whose head not so many days before I had seen seated one of the most lively tigers that I have had the pleasure of shooting. M.'s was on dear staunch old Lal Peeari, whose deeply scarred trunk bears testimony to her plucky encounters with the tiger tribe.

While crossing the river, I slipped the cartridges into my express and Westley Richard's No. 12, two of the best weapons out, and

as we ascended the opposite bank, eager were the looks in the direction of the village in possession.

Villages, by-the-bye, you do not find in this part of the country; that is not in the ordinary acceptation of the word; there are only small clusters of homesteads, two or three homesteads making a little hamlet. Several such hamlets, with the surrounding bamboo clumps, were scattered along the edge of the jungle near the river; close to one of them we saw some hundreds of people sitting and watching the deserted hamlet, *i. e.*, deserted by all but the tiger; this hamlet consisted of some four or five Bengali bharries, four or more mat-walled thatched houses, surrounding a small court-yard being the ordinary form of a bharrie.

Great was the excitement of the people as we came up, longing to be revenged on their enemy; bad enough they thought it to have a cow now and again carried off as it grazed near their homes; but for a tiger to leave the jungle and take up his abode in a village was rather too much, and they were eager to see him killed. As for his being in the little hamlet, of that they had no doubt; they had kept watch on all sides, and he could not have got off unseen.

Our *modus operandi* was quickly settled, a howda on opposite sides of the hamlet, the beating elephants around it. M. took up his position on the side we first approached, a likely looking gully between two houses taking his fancy as a natural line of retreat for the tiger if we turned him out; I went on the opposite side.

We first examined carefully all the cover around the hamlet, and satisfied ourselves that the tiger was not there, and that if anywhere, he was actually among the houses; the next thing was to search the hamlet itself.

Have you ever tried to get inside such a hamlet on an elephant? if not, you can have no idea how difficult it is. The overlopping roofs covering the passages between the houses leave little room for a man to pass, much less for an elephant to squeeze through, and if you do contrive to force your way into a court-yard, there is barely room in it for your elephant to turn round to get out again. Under such circumstances it took some little time before I could be certain that the tiger was not lying in any of the

court-yards or passages between the houses, and that if anywhere he must be inside a house. The question was which house? The khubberier, who was on one of the pads, could point out the shed in which the cow had been killed, but it was so hedged in with houses it was difficult to reach. I determined, however, to get to it, and to do this had to pull down some out-houses. M. meanwhile had taken up his post in front of the gully mentioned above, and was all prepared to let drive.

I could not have believed that mere matting, bamboo, and thatch could offer the resistance they did; but so it was, and it was with no little trouble that I got the elephant I was on to pull down the necessary sheds. What added to the difficulty was, that the elephant trained to respect house property could not understand the unwonted order to destroy. In doing this I could get little assistance from the pad elephants, whose mahouts, apparently scenting tigers behind every wall ready to spring on them, preferred watching outside.

At last the cow shed was reached; it was one side of a small court-yard, and it seemed highly improbable that the tiger was in it, as one or two pariahs lay peacefully in the yard basking in the sun, merely moving with their usual yelping accompaniment from one spot to another as we disturbed them; fowls were quietly perching about, and goats skipped joyfully as if in the most perfect security. The entrance into the cow shed being in a passage so narrow that I could not possibly get into it, I proceeded to pull down its outer wall; this done showed the cow lying dead with a wound in its throat, otherwise untouched, but there was no tiger! Then comes further search and more pulling down of sheds, but still no tiger! I was now convinced that the tiger must be in one of the dwelling houses, improbable as it appeared. These houses are raised on mud platforms from two to three feet high, some mud plastered mat walls and good strong chicks hanging outside their doors, and it certainly did not seem likely that a tiger would understand how to push aside a chick and enter a door. In vain I looked for any chick which showed signs of having been disarranged or forced out of its place. I had not wished to pull down any of these dwelling houses if I could possibly avoid it, but there was no help for it. So I deter-

mined to commence with a small sleeping house, one roomed, which was very near the cow shed; to reach this house another small shed had to be pulled down and the court-yard entered, one of the pad elephants had now joined me, and at last we were in that court-yard, side by side, the elephants' trunks touching the wall of the small sleeping house, their tails flapping against the house on the opposite side of the yard. The beating elephants now commenced to pull down the outer wall of this little house. I had tried leaning over the howda to look in through the chick. But the door was in an inner wall, not in the outer, and the little passage to it was too dark to allow of my seeing anything.

The elephant had great difficulty in getting hold of the outer wall to pull it down. You saw his trunk leech like feeling along the top of the wall and under the thatch roof searching for a hole or something to take grip of; at last he managed to insert his trunk just under the roof and to get it inside the house, but instead of pulling the wall down he commenced feeling all along the inner side; in vain the mahout, with words of endearment, curses, and blows urged the elephant to pull at the wall; he seemed to have made up his mind to make a perfect reconnaisance of the interior with his trunk before he would do anything else, and the house seemed so small that his trunk could almost reach into every corner. I remarked to my mahout that there could be no tiger in this house, or the elephant's trunk would not have got off scot free. At last appearing satisfied with his observation, the elephant seized the top of the wall and began to pull it downwards and upwards; this was followed by showers of dust, and surely the row was enough to arouse any live creature inside, and so it did—the chick moved, was pushed aside, and—out-sprung the tiger! Not a bit of it, out ran a little black goat!! A little goat instead of a tiger, and evidently afraid of nothing but the row we were making!!

The elephant now seemed to think he had done all that was needed, and the period not having as yet arrived when the lion and the lamb shall lie down together in peace, it certainly did not appear at all likely that a tiger would be alone in a room some twelve feet square with a goat and allow it to come out

alive—however, having commenced, there was nothing like going on *pulling the wall down, and making all sure, so at it again* went the elephant; behind the mahout on the pad sat one of the mahout's mates. I was too high above the top of the wall, the mahout a little too low to see well into the room as the elephant gradually brought the wall down: the mate was just about the right height, and kneeling on the pad eagerly did he strain his eyes into the seeming pitchy darkness of the interior of the room, but nothing did he see—a moment or two more and the elephant with a determined pull bent down the wall and pushing the upper bent half with his head, pinned it against the lower half so that a half wall only stood up; greater than ever was the dust as he did it, but just as he had got it well down the mate on the pad pointing into the room called out "there is the tiger." Hardly were the words on his lips, when clean out of the house, over the half wall and on to the beating elephants, leapt a magnificent tiger, such a leap, with loud angry roar, flaming eyes, and well extended jaws, showing his glistening ivory teeth—round flew both elephants. Maula Bux, had he been alone, would never thus have shown his stern to an enemy, but the other elephant swerving, elephant-like he followed suit; there was no bolting, the wall of the opposite house brought them up sharp. Long to describe, it was the work of a moment, and as we wheeled round I managed a flying shot—was there ever a more glorious opportunity for a flying shot—a flying tiger mid-air 'tween house and elephants. Our movements were, however, too rapid for accuracy of aim, as *all those will understand who have experienced what it is to find* yourself suddenly taken off your feet by the unexpected swerve of an elephant, and to feel yourself and rifles knocking about your howda in most unpleasing confusion. Still unsteady as our aim was, a miss was impossible with the huge beast only an inch or so from the muzzle of my rifle, and though nothing could have stayed him from bounding on the elephant's back, he did so with an express ball in his stomach, which so touched him up that though in his rage and agony he bit a piece clear out of the guddy within an ace of the mate's squat, he rolled off as quick as he was up, and slunk with a deep groaning roar between two walls; a second shot was impossible; he was out of sight before I could

have fired, even if I had regained my balance; the one shot had however done its business well, and doubtless saved the mate's life; a narrower shave could hardly have been possible. It was a moment of great excitement and such a sight—one not often seen too, a tiger leaping out of a dwelling house on to the elephant by your side!! M. unfortunately missed all this, only hearing the noise, as from where he was he could see nothing of what went on. He was right, however in his idea of what the tiger would do if ejected, as it had now slunk into the very gully up the mouth of which he was watching, but being a little way up the gully he could not sight it. I too could not see it, and from the nature of this case with the over-lopping roofs of houses on each side it was most difficult to get into any position from which you could do so.

Finding that the land in which the tiger now lay ran up some little way on my side, and was then blocked by a shed, I left the court-yard and had this shed pulled down. This done, my mahout could by stooping over his elephant's head just see the tiger; I was too high up to do so. We then backed till at last by leaning over the howda I could catch a glimpse of the dark outline of something which the mahout said was the tiger. It was difficult at first in the darkness of the gully to make him out, but my eye getting accustomed to it, I presently detected the heavy rise and fall of the dark mass; it was his painful breathing, and being sure that it was my friend, I let drive at what I supposed must be the position of his head. My elephant was steady as a rock, and the sudden start and angry growl told that the shot had gone home; still however his side heaved, so again I fired; he did not rise, but seemed to drag himself just out of my sight and by doing so showed himself to M., who was keenly waiting for him. A shot from M.'s rifle gave him his quietus.

Great was the rejoicing and loud the shouting as the inhabitants and those of the surrounding hamlets pressed in by hundreds to see their dead foe, and a noble beast he was; the tape was passed over him at once, and he was just over 10 feet. I may here observe with reference to the late discussion as to the length of tigers that I have shot many and good sized ones too, but I have never got one more then an inch or two over 10 feet. In fact, a 10-feet tiger is above the average size.

We went to see the small room in which the tiger had been so quietly ensconced, and found that he had been stretching himself on an old woman's bedding, the cotton stuffed pillow of which he had amused himself with tearing to bits; the goat being an interested and unmolested spectator all the time!!

After this we went to a neighbouring hamlet to see the man who had been mauled; we found it was a young fellow, whose curiosity prompted him to get a near view of a tiger, and who accordingly, when the inhabitants ran off leaving the tiger in possession, went back and climbed to the ridge of a roof whence he commanded a view of the cow shed in which at that moment the tiger was. No sooner was he on the top of the roof than the tiger spotted him, and with a spring was up by his side. Before the young fellow could throw himself off the roof the tiger's claws were in his right arm and the back of his head; the weight of the tiger however made the thatch give way, and while he slipped back into the court-yard the man fell back on the other side of the house and managed to get off. He was very badly wounded, and it seemed doubtful at first if he would live; however, we carried him into the station, and thanks to the skill of a clever surgeon, he was cured in a couple of months.

M. and I rode home well satisfied with the day's work. Mine had been the luck this time, but such is the chance of sports, it will be his next, though I fear his will be delayed, as *his services being required* in connection with famine in another part of India, he has left us, and when I last heard from him he told me that he often looks lovingly at his now idle guns, and thinks of the days gone bye.

Such dear reader is a day's tiger shooting, and if by chance you have never tried it, I can only say do so when you get the opportunity, and I know you will agree with me that it is the best shooting out.

R. M.

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The Darjeeling Forests.

BY J. SYKES GAMBLE, B.A.

Byron's Lines,

> There is a pleasure in the pathless woods,
> There is a rapture by the lonely shore,
> There is society where none intrudes
> By the deep sea with music in its roar,

were written when the author was sunning himself on the smiling shores of the Adriatic, looking over the blue waves at the bluer skies overhead, and meditating on the future of Italy, but though perhaps we have most of us in this country little to talk about the lonely shores which can rarely excite else than the desire to cross them to revisit our friends; yet to a lover of scenery, a lover of nature in general, and to the lover of vegetation, and that tree vegetation in particular, there are few scenes so attractive, few places where solitude is less felt than in the vast luxuriant semi-tropical forest of the N. E. Himalaya.

Sikkim and Bhutan are well-known names to those who have looked over old forest records, or studied the plant collections of Hooker and Wallich and Griffith, but there are few who have had the privilege to explore the deepv alleys filled with strange vegetable forms, serpent-like lianas, trees of monstrous size and shape, perhaps clothed with the fairy blossoms of epiphytic orchids or the delicate tracery of pendent ferns to mount thence upwinding paths through dark forests whose only colour is that of the mossy hangings of the gigantic stems or the occasional flower of the scented magnolia to the regions of winter snow where masses of Rhododendron cover with their gorgeous tints the slopes of the upper hills and twist in every conceivable shape their wonderfully-coloured limbs. There are in fact in India few places where such an exuberance of vegetation,

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such a wonderful series of forest forms are to be found than in the forests of British Sikkim and Bhutan. There is to be found nearly every possible kind of forest from the dense-growing straight-stemmed sal of the plains to the massive trunks of the chestnut and oak in the temperate regions, the Rhododendrons birch, alder and whitebeam of the cold climates and the pine forest of the almost perpetual snow. The forests of the Darjeeling district—not those under the Forest Department, although it too possesses specimens of most kind—but the forests, in general, are more varied probably than those of any other district in India. As the soil varies or the hill slopes are more or less protected from the sun or from the rain, a different vegetation is always to be seen—but always interesting—everywhere producing some new form, but always interesting to the forester or the botanist.

Proceeding to our examination of the different kinds of forest met with in this district, it will be best first to explain how the district is situated and how it happens that in such a small area (1,010 square miles) so many varied kinds of forest are met with and so many species of tree. If we look at the map of Bengal and follow from the sea in a northerly direction the courses of the Ganges and Brahmaputra, we notice at once that between those two rivers, stretching right up to the foot of the Himalaya, is a vast tract of fertile level plain; that directly we pass to the west of the Ganges at its turn near Rajmehal we find the Sonthal Hills, and to the east of the Brahmaputra near its turn towards Goalpara the Garrow Hills, both forming a sort of guardian pillars of Hercules to the plains between. Up these plains then travels the raincloud, to drop its burthen on the first slopes of the Himalaya in the districts of Darjeeling and Julpigori. There are few finer sights than to stand on the lower hills about Pankabarry or Choonbutty (higher up the mists encumber the view) and watch the rainclouds sweeping up from the Bay of Bengal to discharge their contents on the Darjeeling hills. The Darjeeling district proper consists of a high range of hills, offshoots of the great group of Kinchinjunga so long esteemed the highest in the world and even now only reduced to second eminence by a not far distant

neighbour; then to the east, the deep valley of the Teesta, and beyond that another high group springs from the Choea range, which goes off southward half way between the lofty peaks of Chumalari and Donkia. Thus our raincloud, travelling northwards, strikes first on the rugged precipices on either side of the Teesta and penetrates up that valley, and those of its smaller neighbours; the Balasun, Mahanuddy and Juldoka, dropping its watery burden as it goes. In front of the hills, and stretching down southwards for a distance of about 10 miles, lies the Terai. We have thus several zones of altitude which present different features of vegetation.

The rainfall of the district is rather variable. In some parts it falls heavier than in others; thus there is always less rain in Darjeeling than at Sonada or Rungbee. The average rainfall at Darjeeling amounts to 125 inches.

The rain chiefly falls in the months of June, July, August and September, and there is little in November, December, January, February and March.

The mean temperature at Darjeeling is 55°, monthly average, highest 64°, lowest 41°.

The front face of the hill-region is almost invariably steep, and more especially so in the eastern hills, where some of the rivers, in a course of at most 10 miles, make a descent of 10,000 feet.

Besides the Teesta and its feeders, which form almost the whole of the northern boundary and meeting in the middle pass southwards through the district, the chief rivers are—

The *Mechi* on the Nepal frontier;

The *Balasun*, a large impetuous river, which in the rains often does immense damage by the piles of drift and enormous boulders which it brings down;

The *Mahanadi* draining the lower hills to the south of Mahalderam;

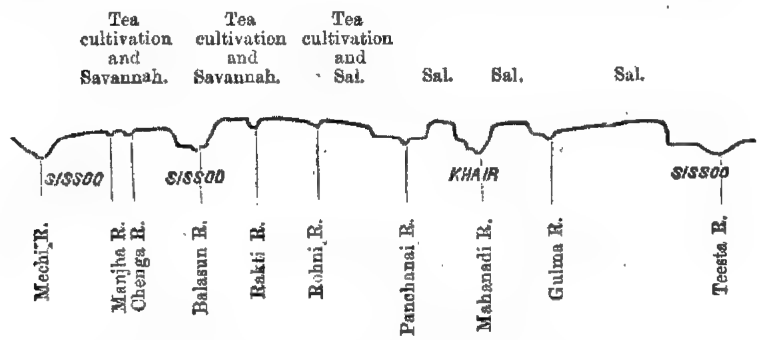
The *Chel*, the *Neora*, and the *Murti* draining the eastern hills; and

The *Jaldoka* on the Bhutan frontier.

The highest mountain is *Phulloot*, 12,336 feet, after which are Sundukpho, Suburkum, Rechee La, Tongloo, Senchal

and Punkasary, the latter two being, it may be said, the centres respectively of the western and eastern hills.

On proceeding northwards from the plains towards the hills, and after leaving the rice fields, a gentle slope is ascended leading up to the base of the lower spurs, a slope covered with forest or with the clearances made for tea-cultivation. This slope is due to the sandy deposits of the numerous rivers which now cut through them again, so that their banks are invariably marked by steep ridges reaching up to nearly 400 feet in height in places, so that a section drawn across the Terai presents pretty much the appearance in the figure. Between the rivers and the first ridges are generally patches of sissoo and khair forest; at the foot of the ridges themselves are often bands of evergreen swamp forest,



while above, the ridges are occupied either by sal forest, or savannah tracts. These we will now proceed to describe in detail.

The distribution of the forests.

Formerly, there can be but little doubt, the greater part of the district was forest, and even now the proportion is very large, though the forest area is rapidly diminishing through the extension of tea-cultivation in the plains and the western hills, and the settlement of Bhuteas and Nepalese towards the east. The different kinds of forest are many and varied, and we will now attempt to describe them *seriatim.*

1.—*Sal forests* occupy the better-drained portions of the Western Terai, the front face of the lower hills up to about 2,500 feet from the Mechi River on the west to the Chel River at Dalingkote and the valleys of the Teesta, Rungeet and Rungpo

on either side, almost continuously from the plains as far as the frontier of Sikkim.

2.—*Sissoo forests* occupy merely the low ground on the banks of the rivers often mixed with khair.

3.—*Savannah forests* are the grass tracts with occasional trees, or forest predominating in neither sal nor sissoo, chiefly found in the Western Terai.

4.—*Mixed forests* occupy the greater portion of the district up to an altitude of 6,000 feet; they may divided into—

1*st.*—*Mixed Plains Forest.*—Of these there are not many examples, with the notable exceptions of the Dulka Jhar in the west, and almost the whole of the Eastern Terai, though in consequence of its little value this is generally classed as savannah. Occasionally also patches are found at the bases of the ridges, and notably we can cite the 'Singaree Pahar' forest near the Teesta.

2*nd.*—*Lower Hill Forest* covering the whole of the Hills up to an elevation of 3,000 feet, with the exceptions of the sal tracts.

3*rd.*—*Middle Hill Forests* between 3,000 and 6,000 feet elevation; of this there are now very few examples west of the Teesta, though east of that river it is perhaps the most valuable of the forests.

5.—*Temperate forests* cover the hills above an elevation of 6,000 feet. We may distinguish them as—

1*st.*—*Oak forests*, in which the prevailing trees are the oaks, chestnuts and magnolias; they cover all the high spurs between 6,000 and 8,000 feet.

2*nd.*—*Rhododendron forests* appear above 8,000 feet, chiefly in Tonglo and Rechee La, but at about 11,000 feet are replaced by

3*rd.*—*Fir forests* only found in the Singalelah ridge, from Sundukpho to Phulloot 12,000 feet.

Sal Forest.

1*st.*—*Sal Forest in the Terai.*

There can be little doubt but that formerly the sal tree covered nearly the whole of the more elevated and drier parts of the Terai. It is now, however, chiefly restricted to the sandy ridges between the Balasun and Mechi Rivers, and

between the Mahanadi and the Teesta. But there is this difference—that whereas the sal forests in the latter tract lie under the hills and rarely reach further from it than 5 miles, those in the former only begin at that distance from the hills and stretch on down almost to the extreme south of the district; these western forests differ also materially in constitution from those towards the Teesta, so that while the Teesta forests, owing to extensive fellings, have been in many places almost entirely replaced by long grasses, in the western ones the long grass is scarcely known, and the sal comes up almost pure in myriads of seedlings wherever a little light is opened out to the soil. The general appearance of many of the Western forests is that of being regularly worked by the system of natural reproduction, where the seed, secondary and final cuttings have all been heavy, though naturally it is too much in patches for the application of anything like a ready-made working plan. These forests cover ridges, and are surrounded by cultivation, and it is remarkable that in many places where the cultivation has been stopped and the land allowed to lie fallow a dense crop of young sal has immediately grown up. Where the seed comes from is a mystery, as it is not of a kind easily transported by the wind, but the fact remains. Of other species of tree there are few, except that as the sal gets older it seems to associate itself with other kinds, and particularly the *Dillenia pentagyna* and the *Terminalia chebula and belerica.* The undergrowth is really dense, and in it is often seen the curious *Cycas circinalis,* which, though very common in many parts of India, is not so in the Darjeeling district. These forests could easily be put under a systematic working plan and reproduced naturally, but unfortunately very few of them are now in the hands of Government.

Turning to the Teesta forests the conditions are quite different. When trees are felled—instead of the fine mass of young seedlings already described long grass comes up thicker and thicker. But this even would make little difference, as the sal seedlings, or rather, in most cases, the shoots of sal described by Mr. Baden Powell, at page 67 of the 1872-73 report, shew no objection to

coming up with the grass; if there were no such thing as jungle-fires to make a clean sweep, year after year, of all low growth, and to torture into every conceivable shape of gnarled and twisted ugliness, the few wretched remnants of the old virgin forest. This is very particularly noticed in the large private forest of Bykantpore, south of the Government reserves, which, though actually in the district of Julpigori, geographically belongs to the Terai portion of the Darjeeling district. This forest, said formerly to have consisted of fine large sal, has been worked to such an extent, that only two years ago every tree fit to give a small 'bully' of 2 feet girth was cut out, and that now, instead of reproducing itself, it cannot fail to deteriorate year after year, till at last, though the soil is scarcely suitable, it will either be put under cultivation or kept as a perpetual grazing ground. Some parts of the Government reserve are not much better, and the experiments on the making of firepaths to keep out fires have all failed, but as a better supervision is kept up and greater punishments are inflicted on people found igniting the forest, now than heretofore, it is to be hoped that in a short time we shall be able successfully to strive against fire and grass, and again send into market sal timber of the fine description of the old trees cut down in the wasteful times before forest conservancy was thought of, and which, unfortunately, are still by no means remote in Bengal.

The general appearance of the Teesta Terai sal forests is very variable; towards the boundaries the aspect is chiefly that of a vast expanse of long grass, dotted with a few sal of stunted and unhealthy growth, a few big-leaved *Dillenias*, the white-stemmed *Eugenia obovata*, and the scarlet-flowered *Butea*. If, however, we examine the ground, we find almost always large numbers of seedlings or stump shoots. The grass gradually disappears as the forest improves, and the older portions, the tall stems of the sal trees growing barely a few feet apart, their monotony occasionally relieved by the gigantic leaves and twisted stems of the *Dillenia*, the gouty-looking trunks of the *Sterculia* with its bright coloured red pods, the scaly bark and ashy foliage of the *Lagerströmia parviflora*, and last, though not least in importance, the serpentine folds of the gigantic creepers the

Bauhinia Vahlii and *Spatholobus setaceus,* throwing their arms in graceful curves from tree to tree, and supporting thus in the hollows of their bends an occasional bright-flowered orchid or pendent *Hoya,* have a fine appearance though scarcely to be surpassed with the tropical luxuriance of the Lower Hill valleys or the majestic grandeur of the upper ridges.

In these older portions there is very little undergrowth; a few seedlings, but rarely of sal, as that seems to thrive best wherever a little light is admitted; and in the rainy season a dense crop of *Leea,* which however all dies down at the beginning of the cold weather. As for the working plan, until the forests have a little recovered it will scarcely be required, though the data are ready for its preparation, but a few points will have to be remarked, *viz.,* that the seed cutt ing will have to be very slight, and in general confined to the extraction of the less useful trees, the extraction of the material cut done quickly and immediately before the seed time, that is, in April and May, and curtains of protection left on the boundary lines and along roads to preclude any possibility of fire.

2nd.—The sal forests of the Lower Hills and Valleys are quite different again. They generally occupy the ridges towards the plains or the rivers, and have always a finer and more healthy growth than the plains sal forest. The general appearance of these forests is also very different; there we rarely find any of the long grass which characterizes the greater part of the Terai forests. This is replaced by a short wiry bamboo-like grass '*Pogonanthera,*' or in the more exposed places by a tall stiff species of '*Erianthus.*' The sal generally occupies the warm slopes towards the plains or the river, and its general growth is very quick. It grow straight and tall, and rarely branches till after 50 or 60 feet from the ground. The sal is not usually a handsome tree, but few trees have a finer appearance than a very old straight grown sal of the Rungeet Valley—with its lofty deeply-furrowed stem, irregular spreading branches and short crown—recalling the appearance of the fine Scotch fir of Strathspey, the old spruces of the Jura, or the larches of the valley of the Inn. The young forests are dense and closely

grown, and differ from the Terai sal in the thick almost gouty appearance of the young bark. These forests will not be difficult of management under a working plan, as the danger for fire, though still by no means to be neglected, is very much less than it is in the Terai. In describing the distribution of sal in the Lower Hills, we will commence, as usual, from the west. Between the Mechi and the Balasun there is little old sal, though the charred and blackened trunks, so commonly met with, and the fine young growth on the warm ridges, shew that there is little doubt that formerly these hills were covered with trees as fine as are now met with in the more or less inaccessible upper valleys of the Rungeet and Rungpo. East of the Balasun there is little sal till we reach the Rohoni River, except a few fine old trees on the west of the Bamunpokri spur, but east of the Rohoni, away to the Chel River for a distance in a straight line of 20 miles, is an almost unbroken forest, the ridges covered with sal alternating with deep valleys filled with the various tropical forms of the evergreen forests, conspicuous among which tower the gigantic *Terminalias*, with *Cedrela*, *Schima*, *Duabanga* and *Bombax*, and thousands of smaller trees of every possible kind. East of the Chel River the sal appears to cease, and it is a curious fact that it is also at this point that the only gap in the line of Tertiary formation along the Himalayas from, as stated by Mr. Mallet,* " the Indus to the Brama Khund" is found. Turning to the valley forest there is little but sal on all the drier slopes of the Teesta valley, and the tree penetrates to the west up the Rungeet and Rumaun, and to the east up the Rungpo and Rushett, in the whole of which long line it is almost universally found up to an altitude of about 3,000 feet. But it is a very curious thing that except just at the mouths of the Reyang and Rilli sal is rarely, if ever, found in the lateral valleys, and almost never in those of the Balasun, Mahanadi, and Juldoka. The finest blocks of sal forest are undoubtedly those at Reyang and Rilli, and these are the more accessible. The forests of the Rungpo are also very good, and are now under examination. The sal of the Rungeet is also very fine,

* Memoirs of the Geological Survey of India, Vol. XI., Pt. 1.

and while speaking of it we can notice that on the Sikkim side of the river it grows almost everywhere mixed with the '*Pinus longifolia*,' while on the Darjeeling side there is only one solitary patch of about 200 acres containing this mixture. This is due to the fact that the '*Pinus longifolia*' will scarcely grow except on a due southern slope, where it is constantly under the direct rays of the sun, while the rainfall of the front of the Himalayas is too great. This forest satisfies this condition, as it lies at the mouth of the Rungnoo River running straight northwards from a little above Darjeeling. The growth of the pine is handsome, but not so fine in British as in Independent Territory. Its wood is not much used, though some of the oldest Darjeeling houses are said to have been built of it, and that it has never required renewal.

The sal forest of the Darjeeling division, which are under Government, form the chief source of the Forest Revenue of the division, and the greater portion of this revenue is derived from the supply of Public Departments, such as the Public Works and the Northern Bengal State Railway. The timber is worked out in log by departmental agency for the most part. The forests of the part of the Lower Hills accessible to elephants, and those of the Terai, have been so much worked formerly that almost complete rest will be required to put them in proper order and make them what they should be—the suppliers in conjunction with the Julpigori forests of the sal trade of Lower Bengal. In the vallays there is still a large quantity of mature timber, and artificial improvements have so improved the Teesta River that logs can now be floated with very little loss from the upper forest to the depôt at Julpigori, the most important and most central point of Nothern Bengal, as being situated on a fine floating river and as the terminus of the Northern Bengal State Railway.

Sissoo Forests.

Of sissoo forest the extent is very small, as not only are the forests confined exclusively to the banks of the rivers, but they are rarely sufficiently pure, as we shall see in taking them in order.

The Mechi and Balasun forests are, scarcely speaking, true sissoo forests, as the sissoo is so intermixed with other species as rarely to be even the prevailing tree, and justify the name. Of the other trees the commonest are *Acacia catechu*, *Albizzia elata*, *Bombax malabaricum*, *Nauclea cordifolia*, *Garuga pinnata*, while the very slight undergrowth is chiefly formed of prickly climbing *Acacias*, and an occasional shrub of *Capparis*. In the rainy season the water generally floods these forests, so that the seedlings are usually washed away before they have time to fix themselves firmly in the loose sandy soil. The sissoo is generally of large size, and is tolerably straight in stem; it is in great demand about Nuksurbarry for export to the Purneah district for the manufacture of cart wheels. Proceeding eastwards there is very little, except a small strip on the bank of the Rakti, which chiefly consists of "sissoo," "khair," and the white "siriss," and which is capable of being easily reproduced naturally; until we reach the Mahanadi. This river is bordered for about five miles along its western bank with a dense forest of "khair" and sissoo in the proportion of two of the former to one of the latter. This forest is very interesting; it rises in steps from the bed of the river. Each year some new piece seems to be left dry by the water and is immediately covered with a dense crop of young khair and sissoo, while the plateaux, as they ascend, hold older and older forest, the last containing almost entirely old trees with little or no undergrowth. This forest could adapt itself undoubtedly to a working plan under the system of natural reproduction, and although at present khair is of very little value in Bengal, as the extraction of cutch is not practised, yet, with the approach of the Railway with whom its timber would be valuable for sleepers and for fuel, such forests as these will deserve a very careful systematic working under that method. Of this kind of forest there are about 1,000 acres only, of which nearly 600 are Government Reserve, the remainder belongs chiefly to planters, who make charcoal of the trees. Eastward of this—with a few exceptions near Sivoke—the khair disappears, and in the small sissoo forests, which line the Teesta, Chel, Murti, and Jaldoka, the sissoo is

always pure, though rarely of any size, and scarcely covering large enough areas to deserve notice.

The present demand for sissoo is chiefly for cart wheels for the carts used on the Ganges—Darjeeling Road; but were carriage cheaper, there can be little doubt that it would sell well in Lower Bengal for furniture and house-fittings.

Savannah Forest.

This will require but little notice. They are generally large tracts of long grass with here and there a tree, generally of species not usually in request. Of the trees which are found in these tracts the most common is the Palass, *Butea frondosa;* the *Dillenia pentagyna*, *Eugenia obovata*, and two species of *Randia* make up the usual vegetation of the true savannahs, where the grass grows high over the back of the elephant you ride, and in the dry season, after the annual fires have swept fiercely over it, serves for the grazing of herds of buffalos, brought up from the plains of Bengal to seek the short rich young shoots which are so fattening. To describe the distribution of these savannah forests would be difficult, as they are usually found interspersed with patches of good forest. A kind of forest, which, though stocked with timber, must really be classed savannah, is that often called "creeper jungle," where the vegetation consists of small trees of stunted growth intertwined with innumerable creepers, among which we may chiefly remark the blue-flowered *Pueraria tuberosa*, the *Entada scandens* with its curious quadrangular stems, and the thorny *Acacia pennata* and *Intsia*. The commonest small trees are *Callicarpa arborea*, *Kydia calycina*, and *Calosanthes Indica;* but they rarely reach a size which would make them of any value. The only trees with wood of any use, which are occasionally found in these tracts, are the *Cedrela Toona*, *Dalbergia latifolia* (which however rarely grows to any size), and *Acacia ferruginea*. These tracts are those usually selected by the Mechis, the wandering tribe of the Terai forest, for their cultivation, and are chiefly put under cotton, which, though rarely of good staple, yet

seem to thrive wonderfully in the black mould given by the soil of forest undisturbed for such a long time.

These creeper savannahs are very noticeable between the Mechi and Balasun, wherever they have not been taken up for tea cultivation; they are very well seen along the old road to Darjeeling by Punkabarry; they cover a large tract of land towards the Mahanadi River; and most noticeable of all, they occupy the whole of the Eastern Terai, east of the Chel River, with the exception of the reserved forest between the Murti and Jaldoka Rivers. The Eastern Terai savannah is very curious in the absence of long grass, which is replaced by a dense thicket of small shrubs all closely bound together by innumerable wiry creepers chiefly *Convolvulaceæ.* There, occasionally, a gigantic timber tree, such as the *Duabanga*, lifts its head over the dense undergrowth; the numerous streams run in pebbly channels overhung with a continuous arch of moisture-loving trees, and the only means of penetrating the forests is along the rough paths cut by the Mechis from patch to patch of their cotton cultivation; or, in the northern parts, along the tracks made by the wild elephants and buffalos, in their travels from feeding ground to feeding ground.

Mixed Forests.

Plains.—Of this there is not very much, as already noticed, as we have described the greater part of the Eastern Terai under 'savannah.' This kind of forest is often called 'Evergreen Forest;' but this, though a very true term in certain cases, is scarcely applicable in all, as the best definition of mixed plains forest is 'forest of different species of timber trees of value in which neither sal nor sissoo sufficiently predominate as to give their name to them.'

The 'Dulka Jhar is a large tract of about 4,000 acres, of which about 1,000 may be said to be 'sal forest,' and the rest mixed. It contains most of the ordinary evergreen trees, but chief among them the "*Chilauni*" *Schima Wallichii*, a large tree with a good timber which has lately come much into use. To attempt to describe the different species of tree growing in such a forest would be a work of some difficulty,

as the number of them is so enormous, but besides *Schima* we may mention as useful trees the *Terminalia tomentosa* and *myriopteron*, *Artocarpus chaplasha*, and *Cinnamomum glanduliferum*. Figs are exceedingly numerous, especially *Ficus Bengalensis* and *cordifolia* and the India-rubber tree is said to exist, though it is somewhat doubtful whether it is the true *Ficus elastica*. The ground is almost always swampy and the undergrowth is chiefly formed by a dense cane brake, the common species of cane being the *Cymbospathes Jenkinsianus*, *Griff*,* which is much sought for for the innumerable uses to which canes are put in the Himalayas.

It is difficult to give an idea of the luxuriance of the vegetation of such forest as this, and (still better) the Singaree Pahar forest near the Teesta. A swampy ground difficult to walk over covered with a dense growth of curiously shaped ferns; ground orchids—especially notable among which are the tall grass-like but gorgeously-flowered *Arundina*, the *pyramidal Cyrtopera* and *gigantic Araideæ;* then the twisted quickly stems of the different canes climbing up trees whose trunks are clothed with epiphytic orchids and graceful climbing ferns, and whose foliage and flowers it is difficult to discern so dense is the tangled growth. To cut a path through a forest of this description is no easy task. Even the active Nepalese, with their curved 'kukie' or the jungle-living Lepcha, with his straight heavy-loaded 'ban,' can only with great patience and perseverence force their way through the tangled thorny masses of the cane stems. Now and then, in these forests, we meet with gigantic specimens of forest trees, with huge buttressed trunks and branches far away in the air above the lower level of the smaller surrounding trees; such are the Banj, the *Echinocarpus sterculiaceus*, a huge tree with large prickly chestnut-like fruits, the numerous figs, the giant "Semul" *Bombax malabaricum* or the *Terminalia myriopteron:* conspicuous in all the swamps is the red bark and huge apple-like fruit of the *Dillenia Indica;* the *Eugenia formosa* with its broad leaves and clusters of tassel-shaped pink flowers, and the *Pterospermum acerifolium*, whose down is considered an invaluable specific in

* Anderson's Enumeration of the Palms of Sikkim Linnean Society's Journal, Vl. XI. No. 49 of 9th April 1869.

stopping bleeding and healing wounds. One great drawback to the beauty of these forests, however, is the swarm of small insects who haunt the swampy parts, and, especially in the hot season, almost interdict their entrance; another is that at the season when the vegetation is at its greatest luxuriance and beauty, in the rains, it is almost impossible to go through them, even on an elephant.

As for the management of such forests, it is difficult to say how they should be worked, but probably the only plan will be that of cutting a certain number of mature trees every year, if possible, by departmental agency.

Turning to the Eastern Terai, we have already noticed the Savannah parts, and we have only left the Murti—Jaldoka Reserve, which is of a totally different description to the mixed forest of the west. This is a forest of big timber, chiefly "Chilauni" *Schima Wallichii*, with many *Lagerstrœmia parviflora*, *Dillenia pentagyna*, *Eugenia Jambolana*, and a few sal and toon, besides other trees. The whole forest is of old timber and has little or no undergrowth; it could be easily put under a systematic working plan, and is probably capable of amelioration by the gradual introduction of sal and toon in the cuttings. The Chilauni germinates freely wherever there is open ground and light cover; sal the same, so that it will be easy to arrange the cuttings. The seed cutting will have to be tolerably heavy, but a large number of Chilauni should always be left sufficient just to give a complete cover. The second and final cuttings will, of course, depend on the fulness of the germination. The northern is the older part, and the first affectation should there be made; there will also then be less danger for the incursion of grass.

Lower Hill Forest, or the forest from the level of the plains to 3,000 feet, occupy the whole front of the hills and penetrates into the valleys. Although we have described parts of these forests under the head of sal, yet properly, the sal of the front face of the hills should be classsed as 'Lower Hill,' as it is impossible to make, for working plan proposes, such a minute distinction as would be necessary if they were separated.

Between the Mechi and Balasun the Lower Hill Forests have been much spoiled by old cultivation, with the exception of 'Lohagarhi' an isolated hill covered with fine timber, principally 'Saj,' *Terminalia tomentosa.* East of the Balasun we first find the Bamunpokri Plantation Reserve, the upper plateau of which almost entirely resembles the Murti—Jaldoka Forest in its general age and in the prevalence and fine growth of 'Chilauni,' but the slopes of the hill are often covered with dense bamboo thickets (*Dendrocalamus*) which yield a large yearly revenue and which must be carefully protected. A curious point, which is very noticeable, is the general fine growth of most trees on the Lower Hills compared with that in the Terai. Thus the *Dillenia pentagyna,* in the Terai usually a short gouty-looking tree, on the hill sides throws up a stem often branchless from 40 to 50 feet from a massive buttressed base; the *Careya arborea,* in the Terai usually a small gnarled tree—on the hill sides has a tall cylindrical stem and gives a timber which from its dark red color, lightness and capability of being easily worked, ought to be much more used than it is at present; but of course, it is the custom of the country to use sal or toon, and very difficult it is to introduce a new timber. *Lagerströmia parviflora* is another tree, which, especially at Bamunpokri and Sookna, grows to an enormous size though rarely of a size fit to give timber in the Terai. This tree has a fine hard wood, but it is never used, though experiments will shortly be made to test its durability as Railway sleepers. East of Bamunpokri are the Sookna forests, extending away to the Mahanadi and full of valuable timber. Conspicuous among trees of value in these forests are the "Champ," *Magnolia sp.,* and *Michelia champaca,* giving a yellowish-grey easily-worked wood of great demand for planking and furniture; and the "Lampattia" *Duabanga Sonneratoides,* a huge tree easily recognized by its drooping branches bearing large closely set opposite leaves, and terminating in a cluster of big fleshy white flowers succeeded by a dark-coloured capsule. This tree is a recent admission to the list of useful timbers; it is now extensively used for tea boxes; is found to be exceedingly good for 'dugouts'

as it is not liable to warp, and on the Nepal frontier is much used for cattle troughs. Its wood is rather light, open grained, of a yellowish colour, has a satiny lustre, and is smooth to the touch. There is also the "Goguldhup" *Canarium sp.* also extensively used for tea boxes, though its wood is not so good; it is white, rather resembling that of the cotton tree, and is very easily rotted. Near Sookna is a fine forest of sal and chillauni with bamboos on the slopes, and towards the Mahanadi there is a great deal of 'saj,' and a few 'toon,' which have escaped the eyes of the searchers for tea box timber. East of the Mahanadi the vegetation is much damper, the Indian-rubber tree makes its appearance, and the valleys are filled with the strange forms of screw-pines, and 'palms.' Among the latter the most conspicuous after the canes are the curious *Wallichia disticha*, T. Anders., with its leaves arranged in opposite rows in the same plane like those of the *Urania speciosa* of Madagascar; the tall cylindrical stem and fern-like leaves of the *Caryota urens*, the elegant *Areca gracilis*, and most lovely of all, the *Phœnix rupicola*, T. Anders., which, in the precipices of the Goramara and Sivoke Hills, throws out its long slender stem crowned with soft delicate leaves, and yellow flattened seed stalks from crevices where it could hardly be expected to find sufficient soil for its roots. Both the *Wallichia* and *Caryota* are eagerly sought for by the Lepchas, who make a kind of sago from the interior of the stems, and consequently they are both rather in danger of extermination as population increases, unless there is a very strict prohibition against their being cut.

It is difficult to describe the localities where the India-rubber tree flourishes best, as it seems to be found both on the dry sunny ridges with a southern aspect and in the deep steamy valleys, but there is little doubt but that it is much finer and its supply of rubber more complete in the inner valleys running parallel to the base of the hills. The system of the collection of the India-rubber is too well known to need special description, but nearly all the trees of the Darjeeling hills have been much overtapped, and will require some years' rest before they will again give any abundance of sap. It is questionable whether

here at its extreme western locality it is worth cultivation, but it is found to be easily raised from seed, and experiments are now being made in planting it in baskets to fix in the forks of trees; in the course of a year or so the roots penetrate the interstices of the baskets and adhere to the tree while the basket decays. East of the Teesta the lower Hill forests are almost unexplored, though a certain amount of sal has been brought from the Leesh and Gheesh rivers. In the Chel valley round Dalingkot are fine forests of toon, saj, and chilauni, with other gigantic trees, while between the Chel and the Jaldoka the chilauni is the prevailing tree and India-rubber is very scarce, if not entirely absent. The forests of the valleys resemble much those of the lower hills, except that toon is rather more common, and the general vegetation of the Upper Teesta is of a much dryer character than the near the exit of that river at Sivoke. In the Teesta valley and in those of the Chel and Neera canes are very common, in the latter two the *Calamus montanus*, T. Anders., prevails, while that cane, owing to the demand for it, is now almost unknown on the Teesta, and is generally replaced by the slender *C. Leptospadix*, Griff., the common *C. flagellum*, Griff., or the straight growing *C. Schizospathus*, Griff., which latter seems to penetrate the farthest west of all. Noticeable among the useful trees and shrubs of these Lower Hill forests are the Camphorwood, '*Cinnamomum glanduliferum*, the "Taj," *Cinnamomum albiflorum*, large quantities of the bark of which are annually collected and exported as Cassia Cinnamon, and the "Hurdi," *Morinda sp. sp.* shrubs whose roots give a fine yellow dye much used by the Lepchas and Mechis in the bright-coloured cloths worn by them.

The term '*Middle Hill Forest*' has never yet been used to indicate the forests between the elevations of 3,000 and 6,000 feet. The term is not a good one, but it is difficult to find a better.

When the reserved forests of Darjeeling were gazetted in 1865-66, all Government forest lands above an altitude of 6,000 feet, and below that of 3,000 feet, was reserved, and the land between these altitudes was held fit to be given up to cultivation, especially for tea. In those days, it is presumed, the toon tree

was not held to be of much value, and it was probably not contemplated at that time that the demand for toon wood would be so great as it is at present. Now, the finest and largest specimens of toon timber occur just in the belt we are noticing, and when cultivators, first the Lepchas or Nepalese, who burnt the jungle to make fields of maize, murwa or mustard, cleared the land; the toon tree was indiscriminately felled along with other species, and now, in some places, huge logs of toon generally partly burnt are found lying in the middle of the old cultivations, most of which, if brought to depôt, would prove of great value. In the beginning of the year the writer was passing through some Lepcha cultivations in the valley of the Reyang, at an altitude of about 4,000 feet, when he noticed four large toon trees; of these two were still standing, though they had had all their branches lopped and were putting out everywhere small shoots. The other two were lying on the ground, and one of them had been converted into a huge rice-pounder for the use of the Lepchas of a neighbouring house. The cubical contents of these four were :—

No. 1	...	211 c.ft.	standing	actual measurements.
" 2	...	375 "	standing	actual measurements.
" 3	...	720 "	fallen	actual measurements.
" 4	...	400 "	"	(approx. measurements.)

Total ... 1,706 c.ft. Allowing for wastage, and supposing 1,500 cubic feet fit for cutting up, we should have, of ¾ inch tea-box scantling 1 foot broad, the enormous amount of 24,000 running feet. This will give some idea of the size of toon timber in the old forests.

The log No. 3 had { mean girth ... 12 feet.
length ... 80 "

The mean girth of No. 2 was ... 20 "

Similar logs were also seen, subsequently, in Lepcha cultivations on the upper waters of the Balasun, and trees of this size and in fine growth are by no means rare in the forests east of the Teesta, especially round the head of the Rilli valley. The great drawback to the reservation of these forests, however, is that the toon tree is never found to grow gregari-

ously—one here and one there—at the most one per acre, so that the forest could scarcely be reserved on the strength of the toon alone. But there are other trees of great value in these forests, among which we may mention the 'Mahua,' *Engelhardtia spicata,* whose timber, recently introduced, is now a good deal in demand. It is a pretty wood of a light reddish gray colour, has fine medullary rays, and a satiny lustre; the Indian chestnut, *Castanopsis Indica,* the best of the numerous chestnuts of Darjeeling for making shingles; the Cherry, *Cerasus puddum,* a sweet scented wood which works easily and makes beautiful furniture; the "Ootis" or Himalayan alder, *Alnus Nepalensis,* an enormous tree which also reaches up to 7,000 feet, and has a wood resembling that of the English alder, the "Pipli," *Bucklandia populifolia,* which too also reaches up to 7,000 feet, with a fine hard reddish wood, somewhat resembling sal, and lately come into extensive use for planking for which it is found to suit admirably; and last, but by no means least, the walnut, *Juglans regia,* whose favorite habitat appears to be the lower slopes of valley at about 5,000 feet altitude, and of whose timber the door and window-frames of most of the older Darjeeling houses have been constructed. The European character of this middle hill forest is sometimes very remarkable; in one small forest near Kalimpoong the following European trees were found, though of course the species were different:—Oak, chestnut, cherry, maple, birch, alder, all of them fine large trees. The middle hill forest is always much mixed, and in the working plans, we shall have to endeavor to help, as much as possible, the growth of walnut, toon, chestnut, cherry, and pipli, and to make these species replace, as far as possible, the commoner kinds.

This forest reproduces admirably as coppice, instances of which are well seen about 'Nagri,' to the west of the Balasun and around Kalimpoong. At Nagri the chief and almost only species are chestnuts and *mahua,* and it certainly seems that the best system of working these forests at an altitude at which the chief demand is for firewood and charcoal for the tea-plantations with only a limited supply of other timber, except toon, would be that of 'coppice under standard'. To grow toon

properly it will probably be necessary to make plantations, but for ordinary purposes 'coppice under standard' would seem the most profitable. The great difficulty will of course be to transform the present high forest into coppice without allowing it to get into the state of scrub which is so characteristic of the western hill-slopes at 5,000 to 6,000 feet. These slopes, the results of abandoned cultivations, are generally covered with a thick growth of worm-wood with the yellow raspberry and shrubs of the following species: *Mœsa Indica, Sauranja, Eurya,* &c., &c., and a small straight growing tree having much the appearance of the aspen poplar *Macaranga Indica.*

The middle hill forest is at present very scarce west of the Teesta. A few patches on the Tharboo spur and a small forest at Nagri are all that are to be found west of the Balasun River; there are also a few patches on the Nahor, Hopetown, and Dootherea spurs and around Kurseong, but the chief forests are those round the head waters of the Mahanadi River. East of the Teesta they are not common still, till the main ridge is passed, beyond which almost the whole country is forest, and this description consequently finds its place with the others.

A noticeable feature in many of these forests is the prevalence of tree ferns, *Alsophila,* with tall graceful stems and feather foliage, making them at once the most conspicuous and the most beautiful of forest plants; the dense thickets of hill cane *Plectocomia Himalayana,* especially found wherever the rocks are too steep for big trees, and the multitude of large-leaved *Aralias* whose leaves are often much used for feeding cattle.

The Temperate Forests.

Oak forests.—The belt beween 6,000 and 8,000 feet altitude is almost entirely covered with forest consisting of trees of enormous size and majestic appearance. The line of about 6,000 feet altitude is almost everywhere well-marked as being the upper limit of usual cultivation, and because the forests above that line were, almost all, originally reserved for Government purposes, so that when clearances were made they were made below, not above, the approximate 6,000 feet line.

The Oak forests cover the ridges which run from Senchal in different directions, *viz.,* Mahalderam, Tukdah and Goompahar,

with the spurs of Simonbong and Rimbick towards the Rumaun River, west of the Teesta; while east of that river they cover the spurs which radiate from Rechee La towards Thosum La, Pankasarry, and Samthar.

They consist principally of oaks, *Quercus lamellosa, annulata* and sp. sp.; chestnuts, *Castanopsis rufescens; Magnolia Campbellii; Michelia excelsa, lanuginosa and Cathcartii* (the latter two often extending right down to 5,000 feet) laurels, maples and other trees.

Of these by far the commonest is the "*Booke*" *Quercus lamellosa*, a huge spreading tree with large leaves and ringed acorns measuring often 2 inches in diameter. The wood is like that of English oak, but has the medullary rays exceedingly developed. It is very pretty when well worked and polished, but is rather liable to warp, consequently it is chiefly used for big beams for the construction of houses and bridges; it is very greatly in demand in Darjeeling. The most magnificent and probably the most useful trees are the *Champ* or *Magnolias*. The *M. Campbellii* is a fine tree found only between 7,000 and 8,000 feet, and especially on the summit of Senchal. In April when leafless, but covered with its brilliant pink flowers, 8 or 9 inches in diameter, it is a sight alone worth a visit to Darjeeling to have seen, and as at that season also the white magnolia *Michelia excelsa*, also leafless, puts out its masses of snow-white fragrant flowers, these two flowering trees, contrasting with the delicate light green of the young leaves of the maple, and the sombre foliage of the evergreen laurels, make up a forest scene of wonderful beauty. Indeed, at all times, these oak forests have an unceasing charm, whether we see them in the spring with the sunlight piercing through the leaves to light up the different colors of the foliage, or in the rainy season, when in the forest paths, we pass one by one, the giant trunks clothed with masses of brilliant hanging moss, and lowering through the dripping misty atmosphere. But, perhaps, it is in October and November that these forests have their finest appearance, when the leaves turn to shades of every conceivable hue of yellow and red, and the folliage of the trees is dotted with the scarlet seeds of

the magnolia or the bright brown prickly fruits of the hill chestnuts.

In that season, too, the ground vegetation is at its loveliest. Brilliant-flowered balsams and painted-leaved *begonias* peep from every mossy cranny of the dripping rocks; above masses of *Strobilanthes* spread a blue and purple hue over the scene; ferns of every form and species and delicate *Selaginellas* cover every bank, while above the branches are festooned with gorgeously flowered climbers, *Thunbergia*, *Craufurdia*, or *Dicyntra*.

But to return to the magnolias they have a rather light yellowish-colored wood, with a strong and rather unpleasant smell, which is very extensively used for flooring and for furniture. The wood of the chestnut is white, hard and strong; not so liable to shrink and better in damp places than the oak; it is esteemed the best for door-frames, and is very much used for shingles.

There are very few other woods which are ever used, but we may mention three species of laurel, the "Lali," *Phœbe lanceolata*, the "Kaula," *Machilus odoratissimus*, and the "Lepchaphul," *Actinodaphne sp.*, all of which are used for planking, and more especially in native houses; the maple, *Acer Campbelliæ* and the Hill Chilauni, the *Echinocarpus dasycarpus*, with a hard good wood, which is rapidly coming into use. The tree itself is one of the most beautiful in the forest; it rarely grows to a great height of stem, but sends out many branches at about 20 feet from the ground, and the leaves droop round the tree in a most picturesque way. Considering the demand of the stations at Darjeeling and Kurseong, and those of the Public Works, and of the numerous surrounding plantations, these forest will best be worked as high forest; there can be very little doubt but that the system of natural reproduction; of course aided in spots, by artificial dotting in of good species, will succeed admirably. At present from the Foresters' point of view the aspect of the forests round Darjeeling is not very good—as of the standing trees of any size fully $\frac{5}{8}$ths are long past maturity, while another $\frac{2}{8}$ths are younger trees of almost useless timber. The term of maturity of oak, magnolia, and chestnut is probably 120 to 150 years, but the term should

not be too long, and 100 to 120 years will be quite sufficient. When the annual cuttings are made all over mature trees should be cut, as they are often quite worthless, except as fuel, as well as a large number of the useless kinds—leaving merely sufficient to give a very light cover. The oaks, chestnuts, and magnolias all ripen their seeds about the same time, November, and germination generally takes place in the following May, so that the young plants should be up and beginning to establish themselves well before the heavy rains set in. In October, consequently, the moss and small shrubs should be cleared from the cutting, as it seems that the seeds do not germinate until they reach the soil below the mossy covering. In fact, the treatment of these forests should resemble that of the mountain forests in Europe, to which the working plan of a conversion for the "Garden" system to that of natural reproduction has been applied. At present the system of sale of standing trees, one by one, in which naturally only mature trees are cut and over-mature ones left is fast spoiling the forests, though with a small establishment and untrained foresters it was almost impossible to apply a better system. On the higher slopes in these forests the commonest vegetation is that of the small hill bamboo "Maling," which grows very gregariously in exceedingly dense thickets, entirely preventing the growth of other vegetation. On Simonbong below Tongloo at 8,000 to 9,000 feet, it forms a dense compact forest; the stems barely 6 inches apart and growing to a height of 20 to 30 feet. The darkness of this bamboo forest is most curious, and it is only here and there that a solitary birch, yew or magnolia penetrates through the bamboos—probably the last survivors of the old forest before the bamboos usurped its place, and by their dense growth killed off all younger trees. This little "Maling" bamboo is very valuable, as not only is it almost exclusively given as food for ponies in Darjeeling, but its stems split up are made into the mats with which all native houses in the hills are roofed. The chief place where these are made is at Sookia Pokri in the Goompahar forest, and the permit for the right of collecting and working up these bamboos produces a keen competition at the yearly auction.

Among other produce of these forests we may mention the little creeper, *Rubia cordifolia*, the "Manjit" or madder, large quantities of which are yearly exported for dyeing purposes, and the "Chiretta," *Ophelia sp. sp.*, for it seems to be the produce of many and not only one species, which is also greatly exported as a febrifuge.

The Rhododendron Forests, in which the trees are gregarious, are only found on the high points above 8,000 feet, although two tree species, the *R. arboreum* and *R. argenteum*, as well as the beautiful epipytic *R. Dalhousiæ* and *R. Edgeworthii*, and the small shrubby pink-flowered *R. vaccinioides* are found as low as 7,000 feet, and occasionally even lower. The chief species are, *R. Campbelliæ* the commonest in the summit of Tongloo, with twisted pink-barked stems and crimson flower; *R. Falconeri* also common on Tongloo, and easily recognized by its large leaves covered beneath with a dense rusty tomentum, and its cream-coloured flowers; and *R. barbatum*, a smaller kind with bright crimson petals. The flowering season is the end of March and April, and at that time the colour of the forest around Tongloo is most magnificent. The wood of the Rhododendrons is pinkish and close-grained, but is not in general use. It is very good as firewood. Associated with the Rhododendrons we often find the *Andromeda ovalifolia*, the red flowered *Buddleia Colvilli*, and *Hydrangea altissima*, but the commonest trees are the birch, maple and whitebeam, and the yew is occasionably found of immense size, and growing much straighter and taller than it usually does in Europe. Of two trees measured by the writer one had 20 feet girth, but was broken at the top, the other 16 feet with a straight cylindrical stem of 30 feet high.

The Fir Forests have, as yet, scarcely been examined; the principal species is the silver fir, *Abies webbiana*, and with it is often found a juniper, *Juniperus recuwa*, and the *Abies dumosa*. They are not worked as they are so inaccessible, although the fir timber is good, and as they are not the property of Government; but, with the Rhododendron forest form part of the large tract of land given to the Cheeboo Lama in recognition of the services rendered by him to Government.

The Government Reserved Forests in the district occupy 105 square miles, or 9 per cent. of the total area, giving 0·7 acres per head of population: this is only including the forests west of the Teesta*; those east of the Teesta will probably give an area of about 120 square miles more; the reserves include most of the sal and sissoo forests of the Terai (with the exception of the greater part of the western sal), the lower hills facing the plains, almost the whole country between the Mahanadi and Teesta, the Teesta and Rungeet valley forests, and the oak forests of the Senchal, Tukdah and Goompahar ridges. There are, properly, two or even three sub-divisions, and the number of ranges is six, *viz*:—

No. 1.—Sivoke and Lower Teesta Forests.
„ 2.—Sookna and Mahanadi Forests.
„ 3.—Forests west of the Balasun.
„ 4.—Bamunpokri Forests and Plantation.
„ 5.—Temperate Forests.
„ 6.—Upper Teesta and Rungeet Forests.

These are under Foresters, with pay varying from Rs. 20 to 40 per month, and they are assisted by 17 watchers and 5 peons.

1. The timber depôts are:—*Julpigoree*, to which Sivok is merely a feeder depôt. This is the most important, as it receives all the timber from the Teesta and its many tributary rivers, and as the river is always floatable;
2. *Silligori* on the Mahanadi, now not much used, and will be replaced by
3. *Sookna*, the most central point of the Teràï, and especially useful as a sleeper depôt;
4. *Rakti* on the old road to Pankabary, and
5. *Nuksurbary* receive the timber from the western forests.

The chief timbers in use are:—

1. *Sal.*—Exported by purchasers or used by Govt. departs.
2. *Sissoo.*—Ditto ditto ditto.
3. *Toon.*—Local consumption only; tea-boxes and general furniture.
4. Hill timbers for building. { Booke (*Oak.*) / Champ (*Magnolia, &c.*) }

4. Hill timbers for building.	Katoos (*Chestnut.*) Pipli (*Bucklandia.*) Akrot (*Walnut.*) Lali (*Phœbe*) Kaula (*Machilus.*) Lepchaphul (*Actinodaphne.*) Chilauni (*Echinocarpus*).
5. Plains Timbers, for building.	Chilauni (*Schima*). Saj (*Terminalia*). Champ (*Michelia*).
6. For Tea boxes.	Toon (*Cedrela*). Mahua (*Engelhardtia*). Lamputtia (*Duabanga*). Goguldhup, (*Canarium*). Kabashi, (*Maple*).
7. Other useful trees but rarely used.	Khair (*Acacia catechu*). Sitsal, (*Dalbergia latifolia*) Sida (*Lagerströmia parviflora*). Malligiri (*Cinnamomum glanduliferum*). Cham (*Artocarpus Chaplasha*).

The Darjeeling Division Proper has only been constituted in the last year; formerly it formed a sub-division of the Cooch Behar Forest Division, which included the Julpigori and Goalpara districts; the revenue has lately increased considerably. The Revenue of the whole Cooch Behar division was in

	Rs.
1871-72	40,000
1872-73	55,000
1873-74	52,000

while in 1874-75 the revenue of the Darjeeling division alone was Rs. 51,000, or, including outstandings Rs. 58,000.

Considering the rapid extension of tea cultivation, there can be no doubt that the revenue is as yet in its infancy, and that the Darjeeling forests will hereafter be amongst the most valuable in the Indian Empire.

On Grazing.

By J. McKee.

Of many forest questions on which discussion would tend to throw light none appears of greater importance or more complicated in its general features than that of grazing. Treated in connection with its results on young forest growth, or with regard to the large population interested in obtaining good pasturage for their cattle, this subject ranks with the foremost of those relating to forest management, requiring special consideration from both departmental and civil officers. The former are sometimes backward in reflecting that grazing is indispensable to the gaôli and his herds, or do not fully consider how dependant they are on the forests for their requirements in this particular; the latter are apt to discredit the fact that cattle do much injury, or do not appreciate the real extent of damage caused by admitting them into a forest; both sides perhaps have ideas on the subject that will bear correction or may be useful if ventilated through the medium of the "Forester."

The question seems to divide itself into three major heads:—

First.—Grazing looked on from a forest point of view.

Second.—As considered in connection with the peoples' requirements.

Third.—Difficulties in reconciling the two interests.

That damage is caused by allowing cattle to graze in forests which are being restored, is to some extent recognised by the majority of persons acquainted even slightly with forest conservation; but it does not appear to be generally understood how hopeless a fact natural reproduction becomes when this privilege is allowed, nor what vast injury to young growth is rendered certain by the presence of comparatively only a few head of cattle in a forest under improvement by natural means. It is not sufficient to simply prohibit felling or the carting away of usufruct from a tract, which it is desired to bring to a more wooded condition; in addition to such negative advantages something must be done to increase the existing crop by fostering natural reproduction, or by artificial means, such as planting and sowing. Whenever

the former is sufficiently promising to bring about the desired improvement, it is obviously the better of the two methods, owing to its cheapness and to the greater likelihood of the plants so raised succeeding better than those which, having been reared in nurseries, have to run the gauntlet of an after transplanting. But experience has proved that a timber crop cannot be materially increased so long as large herds of cattle, goats, and sheep are allowed to graze at will over the forest; all, or nearly all, the natural seedlings are trampled or browsed down by the animals in their search for food, and much of the sapling growth is injured by the cattle rubbing up against it, or by the cowherds lopping its young branches for fodder, in those places where the grass has dried up or been thoroughly grazed down. Such damage is not so perceptible as a total destruction of seedlings, but must nevertheless be great, as it doubtless causes in most cases an irregular growth, much the same as bad pruning would, and frequently the destruction of the trees for useful purposes, and thus detracts both from their future economic and pecuniary values. Grazing is never allowed in European forests until the new growth, either coppice or seedling, is sufficiently advanced to be beyond injury by cattle, and then only under certain stringent conditions. The herds must subsist on the meadow lands or root crops. Here, in the plains of India, we have little meadow land properly so called, and no root crop to fall back on; but in most provinces there are large areas of private forest and Government waste land available for grazing, which bear so large a proportion to the tracts taken up for special treatment and called reserves, that it is hard to understand how any substantial grievances can arise by completely excluding cattle from the latter.

Experiments have been carried out in the Central Provinces, which seem to prove that in some forests the fact of admitting cattle even in the small number of 1 head to 15 acres will, in four months, completely destroy all seedling growths. The following is the account given:—

Two blocks of forests from which cattle had been excluded for four months—from 1st April to 31st July—were inspected

about the latter date, when large numbers of seedlings of the better classes of timber trees were found in all directions and situations, although the rainfall up to that period had been much below the average. On the 1st August licenses were issued allowing 256 cattle to graze in one of these blocks, containing about 3,840 acres, some few plots of ground in which seedlings were present having first been hedged off to protect them from injury. The block was again inspected towards the end of November, when it was observed that the yearling plants had completely disappeared, except in those places which had been enclosed.

It may be interesting to give here an instance of the damage caused by cattle as described by Darwin in his "Origin of Species," page 83.

"But how important an element enclosure is, I plainly saw "near Farnham, in Surrey. Here there are extensive heaths, "with a few clumps of old Scotch firs on the distant hill-tops. "Within the last ten years large spaces have been enclosed, and "self-sown firs are now springing up in multitudes, so close "together that all cannot live. When I ascertained that "these young trees had not been sown or planted, I was "so much surprised at their numbers that I went to several "points of view, whence I could examine hundreds of "acres of the unenclosed heath, and literally I could not "see a single Scotch fir, except the old planted clumps. But "on looking closely between the stems of the heath, I "found a multitude of seedlings and little trees which had "been perpetually browsed down by the cattle. In one square "yard, at a point some hundred yards distant from one of the "old clumps, I counted thirty-two little trees; and one of them, "with twenty-six rings of growth, had during many years tried "to raise its head above the stems of the heath, and had failed. "No wonder that, as soon as the land was enclosed, it became "thickly clothed with vigorously growing young firs. Yet the "heath was so extremely barren and so extensive that no one "would ever have imagined that cattle would have so closely and "effectually searched it for food. Here we see that cattle abso- "lutely determine the existence of the Scotch fir." Again the

following extract from a paper on the Island of Cyprus, published in the " Revue des Eaux et Forets " for February 1874, is intimately connected with the same subject. " It is not the axe so much that I accuse of having destroyed the forests of Cyprus, as the goat. It is for this animal that the shepherd kindles the great conflagrations, which pick out above all for destruction those forests which are highest and thickest and contain the most fertile soil, which he wishes to convert into grazing land. The goat browses down young reproduction, and leaves in its place endless thickets of cistus, arbubus and broom or rocky exposed ground."

That fire is a chief obstacle to reproduction is now scarcely disputed ; the result of protecting a forest from its ravages for a few years clearly prove it, but it is popularly supposed, and with good reason, that fires are in most cases caused by cowherds for the new crop of grass, which springs up much more luxuriantly in a forest constantly burnt, than in one which has been protected for a year or two ; and, if this opinion is correct, it seems hopeless to effectually exclude the fires without first expelling the graziers ; get rid of the cause and its effect will also disappear, or at least will have a better chance of so doing.

On the other hand, when considered from the agriculturists and grazier's point of view, there can be no doubt that stringent forest protective measures interfere with their convenience, past habits and customs, and in many cases cause considerable loss.

In the provinces to which the writer is attached much of the best grazing land is situated in those tracts immediately under departmental superintendence, and each year about the end of February, when the forests belonging to the villages and those called unreserved, are becoming burnt up with heat or browsed down so close that good pasture can no longer be obtained in them, large herds are sent up to the wilder and more hilly lands, of which the forest reserves form the cream, there to remain until the commencement of the rains, when vegetation around the villages in the plain bursts forth again into new life and admits of their being driven back to the home pastures. These far away grazing tracts are looked upon as all important by the owner of cattle ; he considers them a great reserve to fall back on in the

hot weather, and is willing to pay a year's duty for the privilege of grazing over them for the three and a half months preceding the rains, although it is more than probable he has already paid 12 months' dues to the civil or forest officer of his district for permission to graze in the Government forests adjacent to his village; from which it would appear that, although the unreserved and private forests bears so large a proportion to the reserved areas, they are not in the eyes of the people qualified in all essentials to meet their requirements. But besides the above class of men, who would, as a rule, live at a distance from the forests here alluded to, there is another body with a much stronger claim on the consideration of the department, *viz.*, those whose villages actually adjoin the protected area, and who are nearly or quite dependant on it for good grazing. If these men are sternly shut out from the reserve, they must make the best they can of the village pastures, generally poor enough, sometimes altogether *wanting, or they must strike their tents and* move elsewhere,—an exodus not even meditated by such men without much heart-burning and the greatest reluctance; especially when, as is frequently the case, they own or cultivate a considerable portion of the land belonging to the village in which they live. Again, there are always a large number of cattle in every village, generally the property of the ryots, kept up for field work, which must be present on the spot during the greater part of the year, and for the well-being of such it is absolutely necessary that grazing be obtained within a reasonable distance. But when the only fodder ground within miles happens to be strictly protected against cattle, what is likely to be the result? Clearly the cattle must suffer, in some cases lapse into bad condition and die from want of proper sustenance; complaints of a bitter nature will be made, much ill-feeling towards the department in the abstract and the forest officer in particular as its visible representative be exhibited, and the work of protecting the forest from fire and cattle be made infinitely difficult by the peoples' opposition and obstructiveness; the latter being shewn in a sullen reluctance to give any assistance by labour in extinguishing fires when they break out, the

former by grazing their animals during the night time when the forest chuprasies are off work, and by actually setting fire to the grass in the reserve during the hot weather, which may be done without much fear of detection, for of all forest offences, none is so easily committed and so difficult to trace and punish.

The important question then arises: What are the practicable means of obtaining the two following results? *viz.*: protection to reproduction from cattle, and grazing for the people dependant on the reserves. Three methods suggest themselves, by all of which the above ends may be partially gained, each however containing some difficulty or weak point which will require careful consideration before adoption, and will depend somewhat on the character or shape of the forest to be treated.

First.—When the forest is a long narrow tract.

Secondly.—When the area is more compact and is nearly as broad as long.

In the first case, grazing belts or broad sections half a mile wide might be demarcated at intervals through the breadth of the reserve. This system has, we believe, been introduced into the French forests with success. Its advantage is, that grazing would be placed within fairly easy reach of the adjoining inhabitants, its disadvantages, that the reserve would thereby be split up into numerous compartments, the protection and conservation of which would be more expensive than if it was treated as a whole, as it would necessarily entail more demarcation and a stronger body of forest guards to protect the extended boundaries; besides which it would be always difficult to restrain the graziers and their cattle to the belts put aside for them and prevent them from wandering into the protected area. Still this system might perhaps be worked with success in forests, where the proposed belts could be demarcated or marked out by strongly defined natural boundaries, such as ranges of hills and streams. For the other form of forest, *viz.*, a compact squarish or circular block, a belt of grazing land might be lined off half a mile or upwards in breadth parallel to its outer boundary, in which cattle might be admitted until

the inner forest was improved beyond damage, when an exchange of land could be granted, cattle being allowed into the forest that had undergone improvement, while the outer belt was being restored. This method would have the advantage of placing pasture land immediately within reach of all the villages adjoining the reserve, but the difficulties alluded to above, *viz.*, of cost, and of keeping the animals strictly *within prescribed limits again present themselves. Two boundary* lines would have to be demarcated or in some way distinctly defined, and there would be two lines to protect, one against ordinary trespassers, and the other against grazers. It is probable, however, that in many cases the privilege of obtaining grazing would be so thoroughly appreciated that the people on their own behalf would define the inner line, each village undertaking to demarcate the parallel belt adjacent to itself. There is however another objection to this method that should be stated, *viz.*, that it often happens, at least in the writer's province, that the best portions of forest land are situated nearest the outer boundary, and that they would be thus turned into grazing lands for a long term of years, after which they would be more difficult to bring to a reproductive condition, than at present.

The third arrangement may be applied to either of the foregoing characters of forest. It consists of demarcating and *putting aside two or three large blocks in which cattle might be* allowed grazing, while they are excluded from all the rest of the protected reserve. This system recommends itself as being by far the most simple and least expensive of the three ways of meeting the difficulty. If these blocks are chosen in the proximity of those villages which own the largest herds and have relatively little grazing land of their own, the necessities of greatest importance are satisfied, the objection against the first and second method, *viz.*, of expense, is avoided or much lessened, for experience has proved that the people will, in some cases, undertake the demarcation and protection by burning a line round the blocks set apart for them, and there is no occasion to condemn the best land all round the forest to the damaging effects of large numbers of trampling hungry bullocks and

buffaloes for a long term of years. The one objection against this method is, that certain villages would sustain some inconvenience in being situated at a distance from the open block, but this grievance would be reduced probably to those in which cattle were not numerous, and which therefore might obtain sufficient grazing in the private forests belonging to their own or neighbouring villages. It has been lately carried out in some forests of the Central Provinces, wherever large cattle owners live on the borders of the protected areas, and where these last happen to be the only grazing lands within reach, and has up to the present worked successfully.

Journal of a tour into the Karence country, east of Toungkoo.

By M. H. Ferrars,

Assistant Conservator of Forests in British Burmah.

March 5th.—Tounghoo to *Pyon-choung,* 6 miles.

March 6th.—Pyon-choung to *Paylawa,* on the Thoukyagat river, 15 miles. The road lay through the Government teak plantation; the forest as far as the first ascents is characterized by plentiful production of bad teak. On somewhat higher ground this forest was succeeded by arid forest, consisting almost entirely of creepers. Succeeding this was inferior Eng (*Dipterocarpus tuberculatus*) forest. Above the Eng forest was a a region of unequal evergreen forest, in the better parts of which a *Thitkah* (*Pentace Burmanica*) tree was occasionally met. Finally above the evergreen forest the ground was covered simply with low bamboo jungle.

March 7th.—Paylawa to *Bangalay,* 8½ miles. The road lay through scrub of a few years' growth on old *toungyahs*; (coomrie clearings) stunted teak trees were frequently met. On the higher points elephant grass and bamboos were the principal vegetation. Towards *Bangalay* signs of the stunted forest of high elevations were perceivable; the two *cinchona* trees at Bangalay appeared to be prospering, the larger of the two is seeding; both are spreading moderately in the crown and clearing themselves of the lower branches. Elevation of Bangalay 3,150 feet.

March 8th.—Bangalay to *Kyay-choung*, 7½ miles. The whole country within sight occupied by *toungyah* (coomrie) cultivation, the *yahs* (clearings) of enormous extent, and in most cases but recently cleared. Teak trees lopped and mutilated. The forest that has yielded to this toungyah system probably the evergreen, to judge by the patches left standing.

March 9th.—Kyay-choung to *Moo-choung*, 4 miles. Elevation not great. Toungyah scrub alternating with poor teak forest.

March 10th.—Moo-choung to *Moh-gyoh-pyit-choung*, 1½ miles. Nothing but *toungyahs* far and wide. Patches of evergreen forest in gorges, but imperfect poor forest where spared on the face of the hill side. Wild plantains common. Betel gardens commencing. Both the *cycas* and tree fern frequent.

March 11th.—Moh-gyoh-pyit-choung to *Kwat-tyay*, 4½ miles. Ascent of the watershed; traces of evergreen forest, but neither high nor dense, and interspersed with bamboo. Toungyahs reach as far up as the belt of stunted forest, (forest consisting principally of low branching trees covered with moss) which occurs here at 3,500 feet. Stunted Thitsee (*Melanorrheva usitatissima*) formed the link between the two above forests. The watershed takes a great turn east and west from its main direction. A remarkable difference in the vegetation is observable on the northern and southern aspects. The southern is covered with stunted forest of a very open and sparse character, and a sort of long meadow grass forms the immediate covering of the ground. The northern declivity is clothed with the densest evergreen forest, but abounding in creepers, and destitute of high or large timber trees. A little below the highest point of the watershed, 4,700 feet, *toungyas* were again met, but they were not extensive; the wild tea plant was one of the chief components of the scrub growing on the abandoned yahs. Here the first pine tree, long three-leaved variety (*Pinus Khasyana*) were met, in the shape of a few isolated struggling specimens of different ages.

March 12th.—Kwat-tyay to *Koo-saloh*, 8 miles. North-eastern declivity of *Oo-boh Toung* dense evergreen shrub forest with sparse crooked trees. Striking to the east for Karennee proceed along a great offshoot of the main range, the landscape

presents a perfectly novel appearance, namely that of *toungyah* cultivation in more or less hardy pine forest. The road passed through a forest, transitional to that beyond, in which the occurrence of the pine became more and more frequent. The pines appeared to be spreading on the fresh yahs, and were there the most striking element of the fresh relay of vegetation; they were also the principal element of the older blocks, although still rather sparse, and filled in between with scrub. The same stadia in the development of the pine forest, which we find in Europe were noticeable here; the birch scrub, with large brake ferns and long grass, which so often crops up on eminences and slopes that have deteriorated from leaf-tree to pine forest, has its perfect anti-type here. Similarly miserable struggling forest was found where the trees stood far apart and the ground was unprotected. In these places the ravages of insects were considerable, the stems frequently being deformed by a *tortrix*, which here seems to attack the middle or principal shoot in decided preference to the side shoots, probably owing to its singularly large development. Before reaching the pure pine region, although at equal or even greater elevations, openings covered with elephant grass still continued to occur, and large patches of leaf forest were met with. Even evergreen forest of the finest type, with occasional *Thingan (Hopea odorata)* trees, was found in the transitional pine forest. Ascending a steep eminence—4,500 ft., the decided pine forest was reached. The spring shoots were just developing; they had their spikes about $\frac{3}{4}$ inch long. The pine of this region has spikes 3—4—6 inches long, three in one sheath; the cone has a broad base and rapidly tapers; is about 1 inch in diameter at the base, and $1\frac{1}{2}$ to 2 inches long; the *apophyses* thorny and hooked back.

On the crest of the hill the forest might be called intact, *i.e.*, the trees had reached their maturity. This was generally, but not always, the case on the tops of the high hills, and in a modified degree the forest was spared on the minor ridges and large spurs. The faces of the great slopes, including all the minor spurs, were under the toungyah system. In the mature forest the trees stood tolerably close, and had gained a considerable height for the exposed situation they occupied;

the largest trees in the block girthed 6 to 7 feet, the smallest 4 feet; the timber did not taper much. The growth was uniformly slow—about $\frac{1}{15}$th inch in the year. Turpentine and resin were oozing freely. The ground was covered with a thick layer of humus; this was found to be the case in quite young blocks, and proves with what success fire is excluded. The ground is quite slippery with the mass of dead leaves accumulated upon it. There is no undercover; a few branchy leaf trees fill up gaps, but do not appear ever to have vied with the pines in making height; brake ferns occur in little clusters, and an occasional cycadean is the only other characteristic of the vegetation. The white ants do not infest these forests; dead trees are slowly destroyed by other insects. The pine forest is always strongest on the ridge. It was never met with pure in deep ravines. During the whole of this march the aspect of the hill-side exerted an influence; the pine forest was much purer on the southern declivities, and was largely mixed with leaf trees on the northern; elephant grass was still occasionally found on exposed clearings. Reproduction was observed to take place very readily on deserted *yahs*, where a crest of seeding trees had been left standing on the ridge. Seedlings were found on all places where the thick layer of humus had been recently removed by fire, and where fires had not subsequently taken place. Once a few feet over the ground fire seemed to do very little injury to the young trees, the bark did not appear to suffer. Forest was seldom cut for *yahs* where the trees were over 4 feet in girth. The country makes quite the impression of a tract of European pine forest under management; the different age-classes and the rotation are so conspicuous. All land under *toungyah* cultivation, strictly speaking, presents the same features, but here the lines are more clearly marked and the age-classes more easily distinguishable owing to the character of the prevailing tree. The pine steadily advances from the lowest age-class to the highest; with each few years it shows a marked difference; it begins as young forest and goes on in an even block to become high forest without any uncertain stage; whereas in the *toungyahs* of the leaf-tree forests, the various ages of the scrub are less marked, and before

forest proceeds from it there is a long struggle between different trees and plants for predominance, and at the end of a full timber-generation the trees that held out do not form regular forest, but only a sort of foundation for one. The size of the clearings made in a year is here strikingly less than that of those made in the hills of British Burmah; may be that there are fewer cultivators, or that the land is more productive. At any rate the forest gets a fairer chance—a perfectly fair chance indeed—for there is a tolerable surplus of virgin forest, dotted throughout each valley, which is not to be found in the great toungyah districts of British Burmah. The less accessible hills in the Karennee pine forest seem to be altogether intact.

The different age-classes in the district appear to be equally distributed over the area, but every class is not found in one and the same neighbourhood; the distribution is such as to have a number of allied age-classes together, each class being frequently repeated. The rotation is two-fold. First, there is the set of blocks which are cleared every 15 to 20 years; these are large and are used for raising the main crops. Secondly, there is a set of smaller blocks or strips which are allowed to lie fallow two or three times as long as the former; very good forest forms on these, and the land, when cleared, is suitable for growing a series of vegetable crops, &c. The process of regeneration seems to be this. The bare *yah* on the slope is seeded for a couple of years by the trees left standing on the ridge; there being no combustible matter on the ground, the seedlings get a good start and are fire-proof afterwards; fires however are carefully and in general successfully excluded by the natives. *Kaing* grass (elephant grass) springs up simultaneously with the young pine, but before it has attained its full development—which it requires a few years to do—the young trees have out-topped it, and subsequently they drive it out of the field in their vicinity, paving the way for a quantity of undershrubs and young pine and leaf trees which then further oppress the grass. Under the struggling leaf tree scrub, the pine seedlings, which here seem to thrive in moderate shade, get ahead, and suppress the young leaf trees in their turn. In ten to twenty years the block is full. Under less favourable circumstances

the reproduction takes place in belts downwards from the ridge, the successive young generations of pine supplanting and suppressing the grass and scrub.

March 13*th.*—*Koo-saloh* to *Koo-moh-loh*, 3¾ miles. Pine forest as on the day previous; fine pine trees in the gorges among other trees at 3,400 feet. The landscape reminded forcibly of the parts of the Hartz mountains under spruce. Passed along some ridges, where the crest of seeding trees had been removed. The reproduction of the whole hill had suffered in consequence, and its eventual resumption by pine forest become delayed for an incalculable time. Bamboos and high elephant grass had occupied the vacant space. The denudation of the summit was not due to windfall. Windfalls were not observed anywhere. The growth of the timber improves greatly towards the end of this march. Borings shewed that timber was formed much more rapidly, ½ inch in the year, the girth and height were greater. The largest tree measured was 8 feet 7 inches in girth and 100 feet in height. The cover formed by the high forest was much denser; there were in fact as many trees on the acre as could grow upon it. It would be difficult to point to any other forest tree in these parts for which acreage could be computed, with the exception of the Eng, and sometimes of Pyimma (*Lagerstroemia Reginæ*). The elevation of the luxuriant pine forest was 3,300, and the situation a moderate slope, resting on granite. The temperature of the same place at night was 47° F. A large *curculio* was found in dead wood, the larva bores 2 to 8 inches into the wood.

March 14*th.*—*Koo-moh-loh* to *Doh-loh-gyee*, 5 miles—Met with two species of oak; the one a large timber tree (*Quercus fenestrata*) but the timber coarse. The growth of the tree apparently fast. The other bore more resemblance to the English oaks, but was a stunted tree of no pretensions; the leaves were scolloped, the indentations rounded. The acorn was small and regular, but the cup composed of unthickened fine scales.

The pine forest continued as before. A tree was measured 10 feet 4 inches in girth; it appeared to be about 100 years old. In a part where cultivation had not been carried on for a long time, the sides of the hills were covered with stunted leaf tree

forest instead of pine, or the latter was largely mixed with leaf trees. It would seem that the working develops the pine forest, *i.e.*, makes the opportunity for the pines to monopolize the ground. But pure forest is not always a desideratum. The road descending abruptly and continuing to descend for a considerable length, the pine forest disappeared. It was succeeded first by patches of evergreen mixed with bamboos; and subsequently by bamboos with elephant grass. At the same time a change took place in the subsoil, *viz.*, from sandstone to limestone.

March 15*th.*—*Doh-loh-gyee* to *Thalan-loo*, 6 miles. Forest generally scrub with much elephant grass, some bamboos, and a few large leaf trees. Further on dense moist bamboo jungle. White ants re-appear. Bamboay (*Carega arborea*) and Thitsee become common again. Large areas are covered almost exclusively with Teh (*Diospyros kaki*) and an undergrowth of some cyperacean. Pine forest is still observable on high hills at some distance, towards the east. The elevation markedly decreasing for a second time, the soil becomes arid. Proceeding a little further, some young teak of bad growth was found, and subsequently a considerable number of teak trees, but all of too bad growth to give serviceable timber. Elephant grass was—strange to say—the prevailing undergrowth in this inferior teak forest. Nearly every tree, out of which a sound plank could be got, had been girdled. In some instances the poll of the tree had been killed at a great height from the ground—40 feet or so, for the sake of a straight slender post.

March 16*th.*—*Thalan-loo* to *Gaw-tee-loh*, 7½ miles. The road led along the banks of several streams; *Thingan* trees of various ages and fine development were frequently met with; leaving the stream, teak localities were met with on the slopes, but of very indifferent quality. All serviceable timber was girdled irrespective of size. The girdling had taken place a great number of years since, and some trees that had been felled a long time were still lying in the forest. More and better teak forest was said to be on the adjacent hills. However the teak forest, such as it was, did not continue long, but changed for pure Eng with undergrowth of wild date. In

the Eng forest a second species of pine was found here and there; this pine had two needles in the sheath and the cone was 2 to 3 inches long and slender; in most cases curved. The scales were puckered in round the *apophyse*, so that the latter appeared sunk, instead of, as it generally does, protruding (*Pinus Massoniana*). The low hills in the vicinity were crested with this pine, which is found at a far lower elevation than the pine first described. The growth of the pine trees, which occurred in the Eng forest, was almost imperceptible. The largest pine met with here, was 9 feet 7 inches in girth. The lowest elevation in these forests was 1,000 feet. In a valley some fair teak and pyinkadoh forest was found; the teak trees were high, but nearly all crooked or forked. Any good trees had been girdled. From here the road led into a forest much like the dry forest of the Sittang plains, in which teak was sporadic. The ground rising and becoming very rocky no vegetation was noticeable except bamboos. A few good teak trees had stood scattered throughout, but had all been killed, and some felled. Descending again, the country became more fertile, in a nullah, close to two natural wells of great depth, a quantity of Thitkadoh (*Cedrela Toona*) was observed, and subsequently in following the course of the same stream, Thitkadoh became abundant on its banks. In toungyahs the teak trees were spared, but unmercifully lopped from top to bottom. Much bad growth may be ascribed to this cause. It becomes apparent that the country is a table-land, the average elevation of which will appear from the extremes subsequently noted. Young teak continues to appear from time to time, sometimes in full groups, but as yet it cannot be said that teak forest in any sense has been met. Eng forest develops again, but mixed with Hman (Gardenia) Teh, Bamboay and Khaboung, (*Strychnos nux vomica.*) Coming upon a deep descent the forest becomes worse instead of better, almost nothing beyond small bamboos and scraggy teak.

March 17*th.*—*Gaw-tee-loh* to *Too-choung*, 10 miles. Low hillocks on which the ground seems to be quite barren and burnt up by the sun, sparsely studded with wretched little trees. With this kind of land, Eng and bad teak-producing forest alternate.

Laterite soil appeared in the depressions, clothed with Eng forest, and on limestone eminences with a better kind of dry forest containing most of the members of that in which teak grows, but without the teak. This shews that there must be in the neighbourhood forest capable of producing good teak, but in what quantity it is not possible to surmise. Up to this point the road had led nearly due east; here it took a sharp turn north. So far, Koontie's (the Prince of Karennee) authority was not acknowledged.

March 18th.—Too-choung to *Nanpay-choung*, 10¼ miles; respective elevations 600 to 800 feet. A very inferior kind of teak forest without teak. Not even pyinkadoh (*Xylia dolabri formis*) grew in it. The best tree was Myoukchaw, and even that of poor development. Some hills were passed covered with bare jagged limestone boulders, recalling in miniature the appearance of Arabia Petraea; beyond this the landscape consisted of barren hills bordering a small, narrow, sloping plain covered with bamboo, where *yahs* had not recently been cleared. Kyun-na-lin (*Premna*) was a common tree in this little plain, and some good cutch trees (*Acacia catechu*) were found cut.

March 19th.—Nanpay stream for 5½ miles. Hillocks with bamboos and wretched scrub, almost barren. Landscape as far as the horizon the same. It was mentioned that the coffee-growing country in India bears the character of this place. Elevation 1,600 feet.

March 20th.—Nanpay-choung to *Kyet-poh-gyee*, 12½ miles. Proceed up a valley steadily rising. A total change in the productiveness of the soil. The bottom, and in most cases the sides, of the valley fertile arable land. Where timber was allowed to stand—in but few places and small scraps—Eng forest was luxuriant. Traces of teak were found, but no trees were allowed to attain any size. *Khaboung* and *Lepan* (*Bombax malabaricum*) crop up everywhere. The want of timber appeared to be greatly felt, for small scrub that had been cleared for cultivation was worked up into firewood at great distances from the villages. But this country was on the whole ill fitted for growing timber, for where patches of forest had been purposely spared for the sake of firewood—a surprisingly provident

measure, but inadequately pursued and needing extension—the trees often progressed badly. The cause was probably the want of shelter on the undulating plateau. If the attempt to cultivate timber for the immediate requirements of the villagers were made, and a number of age-classes in small consecutive strips established, the required shelter might be attained. The valley, by which the road entered, terminated in a high table-land consisting of gently undulating hills, mostly bare and all under cultivation. The face of the country was very like Wiltshire. Khaboung and Lepang were the principal trees dotted over the hills. On the eminences the limestone rocks were sometimes barred; large bamboos grew in these places, and were evidently held in great esteem, for each bush was fenced round, probably to protect the shoots, when they sprout out of the ground, from cattle. The *Thitkadoh* tree was very common on the tops of the hillocks, and particularly so in the villages, where it would seem to be planted and to grow very freely. It may here be observed that timber could be extracted from this country only by road; the drainage presents the feature of innumerable land-locked valleys which debar the possibility of floating. At an elevation of 3,300 feet some pines of the 3-needled variety were met. Where the hills are steeper, a slight tendency on the part of the trees to form forest is observable, there *bamboay*, *hman*, a species of oak and a few other trees are met together forming cover. High elephant-grass does not occur, nor does the fallow land become covered with jungle. A species of *Rubus* was noticed which bears a good fruit. In the neighbourhood of the chief village, Kyet-poh-gyee, elevation 3,600 feet, the land was energetically cultivated, the effect presented by the regularly bounded fields with the freshly turned up earth was quite European. From the same land, it is said, a succession of crops can be raised before it is necessary to let it lie fallow. Rye and wheat would probably give a better return on this soil than rice, and diminish the area which has to be put under cultivation at one time. The plough could be advantageously used. Terraces of small paddy fields are ingeniously contrived, so as to make the most of a deficient water supply. The soil here is, if not

richer, and, owing to the different configurations of the ground, more manageable, than that cultivated by the White Karens. The barbarous, irrational, wasteful way in which the latter go to work, contrasts nevertheless very unfavourably with the work of the Red Karens.

March 21st.—Remained at *Kyet-poh-gyee.* A great deal of rain. Extremes of temperature less than in the pine forest, 59° to 86° against 46° to 85.° A constant breeze, sometimes blowing very hard. Heard from a Mr. Manook, who professed to have a five years' agreement with Khon-htee for 1,000 logs of timber per year, that the practice of killing timber before felling was universal in Karennee. The timber is allowed to stand girdled for one year and upwards. It is usual for Khon-htee to work the timber as far as launching it into the Too river, and then to sell it in that condition. A man called Imâm professed to have advanced Khon-htee Rs. 14,000 for timber, which was to be supplied at the rate of Rs. 23-8 per log. The latter timber was to be obtained from the Toochoung forests below a certain point, at which an obstruction exists, and which prevents the extraction of timber from above. The forest above the obstruction in the river was said to be uncommonly rich; below it very poor. Being ordered to make an examination of this district I proceeded by myself for that purpose on the following day.

March 22nd.—*Kyet-poh-gyee* to *Nan-pay-choung,* 13 miles. (The same march as March 20th).

March 23rd.—*Nan-pay-choung* to *Taw-koo,* 15 miles. Quit the undulating country, cross a range of steep hills covered principally with elephant grass. On the other side there are traces of evergreen forest, and thin pine forest on the tops of the hills. All under *toungyah* cultivation. Some fine *Thingadoo* in the evergreen forest. Crossed a second range, of considerable height, from which *Kyet-poh-gyee* could be seen bearing 170° E. The eastern ascent of the range bleak and barren, it becomes more fertile on the west; and as the village of *Taw-koo* comes in sight, a fertile valley opens, where toungyah cultivation is carried on in small strips, as opposed to the enormous spaces laid waste at one time by the White Karens, the condition of soil and conformation being

quite similar. The forest displaced is the evergreen, and contains *Thitkadoh.* The land is turned with a mattock, a manipulation among many others strange to the White Karens, as far as I have been able to observe. Paddy fields were contrived in the ravines. Arrived at the village, I found that it was the last in this direction which practically acknowledged Khon-htee's authority. Khon-htee's agent, whom he had sent to accompany me, said it was not possible to proceed further. There was an apparently well founded rumour that the road to *Brreh,* the basin of the Too stream, above the obstruction had been closed by the people of that district. What is understood by closing the road, is placing some mark, by which a Karen understands that it is not safe to proceed, but which would not deter other persons; and then setting man-traps along the stretch of road or path so marked. The narrow path generally leading along the side of a steep slope, it is difficult to avoid it. I was, however, deterred from making the attempt by reason of the inimical feeling which the act of the *Brreh* people implied, and accordingly stopped at *Taw-koo.* I despatched messengers to Brreh with presents, and an invitation to the headman to come and meet me at Taw-koo; others to *Kyet-poh-gyee* to inform the Deputy Commissioner, the head of the party, and obtain orders on the subject.

March 24th.—Waited at *Taw-koo.* An agent of Imâm's arrived from the Mg-koo-choung, a feeder of the Too-choung, below the obstruction in the river. Having heard that the road was closed, he worked his way up in the beds of the streams. This man had been marking timber that he had bought. He said he had visited the forest above the obstruction, and described it as being uncommonly fine. His mode of expressing his opinion of the rich stock, and the favorable position of the trees was that 150 logs could be turned into the stream in a month with a single elephant. According to his belief there were over 100,000 first-class trees in the forest; 180 trees were killed and some felled with the intention of trying to get them past the obstruction. The attempt was unsuccessful. By blasting a single boulder of not very great dimensions, the stream would be free for timber to pass. There is a great quantity of Thitkadoh in the same forest; pines are also accessible. Toungyahs are

according to his account cut in the regular teak forest for want of any other land to cultivate. There is, however, a large aggregate space which has hitherto escaped. The people of *Brreh* are said to be very poor, and very uncivilized and savage—more so than any others of these parts. They are quite isolated in their valley. They consist of 37 villages and acknowledge no authority outside their own district. The district cannot be as large as the Thonkyagat, but it may be incomparably richer.

March 25th.—*Taw-koo* back to *Kyet-poh-gyee*, 27 miles. Orders arrived in the morning from the Deputy Commissioner to return immediately; which I accordingly did, leaving Khonhtee's agent to meet the Brreh Loo-gyees, and, if possible, induce them to come to head-quarters at *Kyet-poh-gyee.* I distributed a few presents to the headmen of *Taw-koo.*

March 26th.—Remained at *Kyet-poh-gyee.*

March 27th.—Do. do. do.

Heard that there is teak forest on the *Pwon-choong* in large quantity and on both banks. The forest is still intact down to the river banks. The stream is a bad one for floating, chiefly owing to the dense growth of a *Salix* (as I conjecture) out of crevices in the rocky bed. One Ko Oh is at present attempting to clear the stream and bring out timber. He is said to have girdled 5,000 trees. Another man, Boh Nyoh, stated it as his intention to seize and carry off Ko Oh's elephants. Also heard that the timber on the Too-choung tapers considerably; while that on the Pwon is well-shaped.

March 28th.—*Kyet-poh-gyee* to *Noung-pelay*, 14 miles. Country at first of the character already described on March 20th. Advancing the growth of Thitkadoh became perfectly luxuriant. The tree is largely but not systematically planted in the villages, and thrives wonderfully. A small spare plantation of Thitkadoh was met with. Planting is indicated here for that tree (means of transport fail as before); several pieces of fallow land were enclosed with loose stone walls, and planted sparsely with a *ficus* for the sake of firewood, and with another tree—unknown—for the deposit of lac. One spot was planted with ficus, about as close as an orchard; further on the main road was planted on one side with a row of ficus. Having reached the limit of the

high table-land there was a prospect over a plain enclosed between two ranges of hills, and studded with rocky limestone eminences rising abruptly through the laterite soil of the plain. The road descended into the plain by a very gradual slope indeed, and accordingly traversed a great extent of country. The peepul alleys became more and more frequent, and soon the fields were all found enclosed or bordered by rows of these trees. Still lower, the fields were surrounded by ditches and raised banks with trees growing in them. In many places the banks had been planted with young trees so as to form a hedge; the roads led through alleys of trees, had ditches and hedges on both sides, and reminded one forcibly of country lanes in Europe. These fields were carefully tilled, and great attention was evidently paid to the drainage. Gyo (*Scheichera trijuga*) and Yindike (*Dalbergia cultrata*) trees are pretty frequent, and these, as well as many of the trees along the roads and in the hedges, are used for the produce of lac. Reaching the regular plain the ground was laid out for paddy cultivation in a similar manner to that followed in the plains of the Sittang; the several fields being enclosed by a bund about a foot in height. There were no trees here, and it was remarkable that jungle of any kind did not spring up. In the paddy fields were mounds, probably composed of the earth removed in levelling the fields, and which are used for raising other produce, by modifying the moisture of the surface during the floods. In the depressions of the plains a young crop of rice was being raised, the plants were 6 inches to 1 foot high. This was the second crop. The fields were arranged in a very perfect manner, each being absolutely level, with but a few inches of water upon it, and so that a very small supply of water would suffice to irrigate the whole. The stream has been made into a canal; its banks are raised so as to prevent inundation of the rice-fields when the water-level rises, and to allow of the quantity of water being regulated and distributed by small branch canals at pleasure. It is needless to say that no counterpart is found in British Burmah to the intelligence and industry of these cultivators. The lowest elevation in the plains of Noung-pelay is 2,700 feet.

March 30*th.*—Return march, *Noung-pelay* to *Doh-koh-lay*, 10½ miles. Crossed the Noung-pelay and Ngway-toung plain in a westerly direction ; after which the road ran up a narrow valley, merging into the plain from the S. W. The lower part of this valley was occupied with irrigation works of a very elaborate and perfect kind, for the purpose of allowing a second crop of rice to be raised. The upper end of the valley, where it gradually lost itself in the highland—*i.e.,* into undulating country like that already described, and about one thousand feet above the plain—was all terraced for the purpose of storing up the rain-water for the first rice-crop. And further on, wherever the configuration of the soil was favourable, it was terraced in the same way. The Pouk (*Butea frondosa*) tree became very common on this march ; it is a good tree for lac. Gyo was observed also, but rarely. The *Sekkoo* tree, of which the Shans make paper, grows here. At the villages in the highland, bamboo (wah-boh) again frequently occurred, and each clump was fenced in as before ; the bamboo if not indeed directly propagated by artificial means, is preserved with great care. The planting of Thitkadoh and other trees was noticeable. According to some, lac is deposited on Thitkadoh.

March 31*st.*—*Doh-koh-lay* to *Chee-shoh*, 9½ miles. Weeds on the tilled soil are not troublesome; the chief are brake fern, and a kind of *Euphorbium.* On fallow ground *Thekay* grass, and another long grass at the highest about 5 feet, but in general 3 to 4 feet according to aspect and exposure. The plantain was found growing wild on bare rocks. Striking west crossed a high rocky range. The country on the other side was much like what we had left, with the difference that the hills were higher and steeper. Amongst the high bare peaks of the range were often basin-shaped depressions clothed with rich *green sward*—a very curious phenomenon. On both sides of the valley trees began to re-appear, but sparsely and greatly stunted. The lower part of the valley was all terraced, and remarkably fresh grass grew in many parts of it.

April 1*st.*—*Chee-shoh* to *Tee-toung-loo*, 4 miles. Ascended the opposite decline of the last-mentioned valley ; trees almost forming forest. A few patches of pine, and above that stunted

forest of evergreen trees. At the *top* of the ascent the evergreen forest lost its stunted character and became luxuriant; the shade was very deep; the moisture sustained by it appeared to have checked the fires, for they had not invaded this part. A few Thitkah trees were observed, but of slow and inferor growth. Elevation 5,520 feet. On the west decline, dense evergreen forest, containing almost no deciduous trees and with clumps of pine and patches of meadow. The pine forest, though producing longer and larger timber than had yet been met, was represented only in clumps. Clearings made in the evergreen forest at this elevation do not cover in with forest in a few years as they do at lower elevations. The trees of the forest, even where close and apparently vigorous, have the appearance of great age, and of having combated with many influences adverse to their growth. An oak, the first of the two noted above, and a Yew (*Taxus*) grow in this forest. Ivy was very common here, and some of the small compositae in the meadows reminded one of daisies.

April 2nd.—Tee-toung-loo to *Poh-loh choung*, 8¼ miles. Stunted evergreen forest as before; and intact. Reached elevation of 6,000 feet. Begin to descend, and the character of the vegetation changes. No pines. Pass into a toungyah country of the sort inhabited by White Karens; age-classes of deserted yahs not conspicuous; miles and miles cleared at one time. The fallow ground covered with elephant grass and the usual toungyah scrub, despite the elevation—3,000 to 4,000 feet. Descending further, left the toungyahs and came to forest, transitional to teak forest, and at the bottom of the valley, *on the Too-choung* the forest resembled the low tree forest which fills in the areas that are not occupied by teak forest or by bamboo in the dry hills of British Burmah. A successful experiment had been made with lac in this place, somewhat east of the Too, at an elevation of about 3,000 feet. There was no trace of teak on the Too, at the point where we crossed; the teak localities did not commence for some distance down the stream. Mr. Manook, the Timber Merchant, here observed that in his opinion 5,000 logs of timber a year could be taken out of the Too forests for 10 or 15 years before the supply would have been exhausted.

April 3rd.—Poh-loh-choung to *Kasoung*, $8\frac{1}{2}$ miles. Patches of fairly high evergreen forest in the glades and gullies. Toungyah cultivation of the savage description; the bare yahs covering them in very quickly with the same scrub as at low elevations, although in this place the elevation was as great as 4,500 feet.

On this march and the previous ones the ordinary signs of elevation noticeable by the phases of vegetation were unreliable. In a narrow plain, or silted up valley, there was rice cultivation of a low order—about equal to that pursued in the plain of the Sittang—the natural advantages of the place being turned to but a very poor account; a second crop would have been raised here by the Red Karens.

April 4th.—Kasoung to *Kay-choung*, $4\frac{1}{2}$ miles. Evergreen forest along watercourses; otherwise dry bamboo (kyethoung.)

April 5th.—Kay-choung to *Thoukga kat-choung*, $3\frac{1}{4}$ miles. Forest same as on preceding march. Measured a Thingadoo tree 29 feet in girth.

April 6th.—Thoukgakat-choung to *Let-pet-Eng*, 19 miles. Moist bamboo forest; scarcely any yahs for about 4 miles. Then a small tract of country cultivated in the savage manner; the rest of the march toungyah scrub of 5 to 10 years' standing.

April 7th.—Let-pet-Eng to *Tonghoo*, $27\frac{1}{2}$ miles. A second crop of paddy might have been raised on Let-pet-Eng as well as on the Eng passed on the 3rd April. Beyond the Eng, toungyah scrub as before; almost no clearings here either (significant fact in the famine country). Final descent into the Sittang valley through some wretched teak forest. In the better parts, traces of Thitkadoh, with thin patches of seedlings of that tree. Then Eng forest, and the other usual links between the forest of the eastern hills and the forest of the great plains.

Report on the Caoutchouc Plantations in Assam and the Yield of Caoutchouc from Ficus Elastica.

BY GUSTAV MANN,

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THE last report submitted on this subject contained the results of the first attempt to plant *Ficus elastica* in Assam up to the end of March 1874, and this report will therefore record the results of the planting since that date.

2. The different opinions expressed during the year on the growth and yield of *Ficus elastica* have proved to me that facts regarding the nature of this tree, which I had considered clear and established, because I have had such constant opportunities of watching over and increasing my knowledge of the tree, still remain doubtful to others who have not had the same advantage, which induces me to report in greater detail now than I might have otherwise considered necessary.

Plantation of 1873-74.

3. The planting during 1873-74 was reported in the last report as a failure on account of the lateness of the season when started and drought of that year, whilst the nursery work or the propagation of the plants in spring 1874 was reported as a success up to that date.

4. This report on *Ficus elastica* may conveniently be arranged under three heads as follows :—

(1.)—The propagation.

(2.)—The growth in plantations.

(3.)—The yield.

5. The necessity for forming plantations of this tree having been recognized, no further remarks are required, except perhaps the statement that the protection of the caoutchouc trees in the forests of Assam has again during the year been under the consideration of the Chief Commissioner, and the difficulties of protecting this valuable property prove to be almost insurmountable ; scattered as these trees are through the forests situated in the most inaccessible and unhealthy parts of the province, they have been the prey of tribes living near

these localities, and may now be said to be almost a thing of the past.

6. Plantations will of course not be exposed to these risks, and can be easily managed by a comparatively small staff of Government officers.

I.—The propagation of *Ficus elastica.*

7. Figs are perhaps of all the forest trees in India the easiest to propagate, but for all this the past years' experience has taught us that *Ficus elastica,* both as seedling and cutting, is very susceptible of injury from too much shade or drip from trees causing excessive wet about its roots, which experience cost us a number of young plants, but thus established a fact which is of the utmost importance in the propagation of this tree.

Propagation by seed.

8. The seed sown on the Charduar caoutchouc plantation on the nursery beds prepared with broken bricks, broken charcoal, and with earth only, as described in paragraph 19 of last year's report, germinated profusely in April 1874, having at first the appearance of cress, the cotyledons being very small.

9. The artificial shading over these seed-beds, however, caused drip and excessive moisture, which proved fatal to many of the seedlings before the cause of the mischief was recognised.

10. The number saved amounted, however, to about 1,200, which were on an average of the undermentioned sizes as they grew :—

On the 27th June 1874, $\frac{9}{10}$ths of an inch.
" 12th August 1874, $1\frac{2}{10}$ths inch.
" 10th September 1874, $5\frac{7}{10}$ths inches.
" 21st April 1875, 2 feet 10 inches.

It should here be mentioned that the last of these was a seedling which had been left undisturbed in the seed-bed, and was exceptionally vigorous in growth.

Germination of seed.

11. The seed sown germinated most freely on the broken bricks, next best on the charcoal, and least on the earth, and as the seedlings

grew, those on the broken charcoal succeeded eventually best of all, whilst those on earth perished, which however is due partly to the large trees left standing in the nursery and the artificial shade got up, for which there proved to be no necessity.*

12. No perceptible difference was noted in the germination of the seed where the whole fruit had been sown and the fruit had been crushed, except that in the former case the young seedlings were very much crowded.

13. They are remarkably hardy as long as they are not exposed to too much shade and drip from above, causing excessive moisture about the roots.

14. During the last cold season most of them have formed a thick tuberous root resembling those of *Epiphytical rhododendron* and *vaccinium,* by which they no doubt are enabled to stand drought during the dry season much better than cuttings.

Seed nursery of 1874-75.

15. During February and March this year a large nursery, measuring 36,000 square feet, has been prepared in the Charduar plantation by raising beds four feet in width and one foot high, and covering them with 160 maunds of broken charcoal.

16. All trees had been cut down in this nursery and no artificial shade of any description has been given to the seed-beds this spring.

17. On these beds six maunds of seed were sown, the first of which germinated on the 18th April, and they look remarkably well.

18. A small quantity was also sown on earth alone to give this mode of raising seedlings a further trial, since it is more economical than where charcoal is used.

19. About 400 seedlings were brought in by "Miris" which had evidently germinated on the ground, and these men affirm that the seed of *Ficus elastica* germinates freely on the ground wherever there is sufficient light.

Seedlings brought in by Miri villagers.

Since these seedlings were fetched from the Akha hills immediately north of the Charduar plantation, it is easily understood that the seed

* See also Appendix. The Editor.

will germinate on steep hill-sides where there is light whilst for the same reason in the dense evergreen forests along the foot of the hills this is a very rare occurrence.

That the seed of *Ficus elastica* will germinate and grow on the ground is further borne out by the young trees met with in tea gardens where the ground is kept clear.

20. At the Kulsi plantation in the Kamrup district seedlings have been raised in the same way on a small scale with much the same results.

Propagation by cuttings.

21. The cuttings made in spring 1874, and reported on in paragraph 18 of last year's caoutchouc plantation report, suffered in a similar way from drip from the artificial shade and trees left as a precaution in the nursery, which has taught us the same lesson with regard to cuttings as with the seedlings.

22. This experience after all was very cheaply bought, since the cost of the nursery was trifling, and we managed to save 2,000 cuttings which were sufficient for the plantation.

Time for making cuttings.

23. The best time for making cuttings in Assam is no doubt from the middle of January to the end of May, it depending on the rainfall during the latter three months which of the cuttings will do best; those made in 1874, after May, failed almost entirely.

24. The earlier in the season, before the young shoots to be used have started growth, the better chance they have of success, and at this time young terminal shoots will grow well; whilst after the trees from which the cuttings are taken have commenced growth, which happens about the end of January, the lower somewhat harder portion of the young branches succeeds better, than the soft terminal shoots.

Description of cuttings.

25. Only young and vigorous branches from lopped trees are used, and they are cut 1′—2′ in length, and are put three inches in the ground; all scrubby branches from old trees almost invariably fail.

26. The branches from young trees are still better than those of lopped trees, but these are rarely to be had now.

After our young trees are two or three years old, they will furnish any quantity of shoots best suited for cutting.

Nursery for cuttings of 1874-75.

27. The making of the cuttings this spring was begun in the end of January, both at the Charduar and Kulsi plantations, and in the former it was continued until the 19th of March.

28. The beds for the cuttings were raised one foot high, all the paths between the beds being so constructed as to prevent water resting, and as an extra precaution the earth at the Charduar plantation was mixed with river sand since it is rather clayey, retaining moisture longer than suits the cuttings.

29. The nursery for cuttings in the Charduar plantation in the Darrang district, prepared in this way, measures 25,200 square feet, and at the Kulsi plantation in the Kamrup district a small nursery sufficient to grow the cuttings for an extension of 30 acres was prepared and planted.

30. The same artificial shading of grass was employed as last year, but was removed every afternoon and not replaced until about 9 o'clock in the morning, by which more light was ensured to the cuttings during part of the day, and they had the benefit of the night dew.

31. On the 7th of March the first rain fell at the Charduar plantation and continued for some time, which opportunity was taken advantage of to harden off the cuttings and to remove the artificial shading entirely; until rain fell all were watered twice a day.

32. The success of the harder cuttings has been general, whilst amongst the soft young shoots there have been many losses.

Number of cuttings.

33. On the whole the propagation from cuttings has this spring been most successful, there being at the Charduar plantation 16,401 cuttings alive out of 21,213.

34. This is 22 per cent. of failures, which is insignificant, considering that many of the cuttings were necessarily still inferior, young trees, which are the best for cuttings, being extremely scarce.

35. At the Kulsi plantation there are 1,790 cuttings alive and doing well, which is also much more than we require for this year's extension.

36. A small nursery has also been prepared with equal success at the Bamuni hill plantation in the neighbourhood of Tezpur for an extension of 10 acres this year.

II.—The growth in plantations of *Ficus elastica.*

37. The first plantation of *Ficus elastica* in Assam extended over 18 acres, and was started on the right bank of the Kulsi river, about 30 miles west of Gauhati in the Kamrup district, adjoining the experimental teak and sissoo plantations, which are the head-quarters of the officer in charge of the Gauhati forest division.

38. The experiment became a failure from reasons explained in last year's report on caoutchouc plantations, but the old lines have been replanted and 17 acres added, which makes the total area under plant in the Gauhati division 35 acres.

The Kulsi caoutchouc plantation.

39. The method of planting adopted in the Kulsi caoutchouc plantation is the following:—

Lines 20 feet in width and 50 feet apart are opened out in mixed plain and savannah forest, and the trees are planted out on these lines at distances of 25 feet.

40. The plants in this plantation were examined by me on the 26th of April, and the countings showed 2 per cent. of failures, which were filled up the same day. Nothing could surpass the healthiness and vigour of the young trees, whose only enemies are the deer, which has made fencing necessary, but the plants will soon have grown beyond the reach of them.

41. Besides this, 30 acres have been prepared for planting during last cold season, but as the weather up to the end of April was very dry, the planting is only being done now, and these 30 acres have therefore not been brought on the register of area of caoutchouc plantations before the end of the financial year 1874-75.

42. This locality was not chosen for the first plantation, because it was well suited, but on account of the season being far advanced, and there was a forest officer on the spot to look after it.

43. Kamrup is, compared with other districts in Assam, dry, and it is not intended to have caoutchouc plantations on a large scale in this district on this account, since the yield will be proportionately small.

44. All land in the Kulsi plantation reserve not suited for timber plantations will thus be made use of for caoutchouc plantations, which will make the total area about 100 acres. This will furnish a field for experiments in tapping and enable us hereafter to draw comparisons between the yield of caoutchouc from trees in this district and that from the more favourably situated Charduar plantation at the foot of the Himalayas in the Darrang district, 18 miles north of Tezpur.

The Charduar caoutchouc plantation.

45. The latter plantation extended over an area of *180 acres in the year 1873-74.*

The plants in this plantation were examined by me on the 21st of April 1875, and the countings made all through the plantation showed $3\frac{1}{2}$ per cent. of failures.

In addition to this 140 acres more have been got ready, and another 60 acres are in course of clearing for plants.

None of this area has, however, been planted, since the rains will be more suited for this work, and no additional area has for the above reason been brought on the register of area of caoutchouc plantations before the end of 1874-75.

46. The method of planting adopted in the Charduar plantation was the following:—

Lines, 20 feet in width and 100 feet apart, were opened out through lower hill forest, and trees were planted out on these lines at distances of 50 feet.

47. The width of the lines proved insufficient as soon as the rains set in, and the excessive shade and drip from the trees on either side of the line proved injurious, and in many cases fatal to the plants.

48. The plantings on split stumps of trees and in earthenware rings, placed with the widest opening on stumps, was suggested by the Chief Commissioner and proved very successful in low situations, counteracting the excessive wet on the ground, but vigorous growth was not insured until more light was admitted.

49. All the lines of last year's plantation were therefore opened to 40 feet in width, and the effect on the young trees has already been most beneficial, so that, although it is only the commencement of the growing season, nothing could surpass the vigour and healthy appearance of the trees, and so far as the planting on lines opened out through the forest goes it certainly is a perfect success.

50. The ground on these lines is not cleared except just around the plants, but the opening out of bridle paths has become necessary to save time in going over the plants, but since frequent inspection is the only way to prevent any vacancies remaining in the plantation.

51. The growth of low jungle or scrub in these lines has neither been such as to necessitate subsequent clearing.

52. The opening out of these lines to double the width has however doubled the cost of this, the chief work in the plantation, and besides the daily increasing demand for labour on the tea gardens has induced the planters to pay absurdly high wages, thus making local labour, which only is suited for the caoutchouc plantation work, scarcer every day.

Planting in the forks of trees.

53. For this reason experiments have been started to plant the young trees in strongly-made cane baskets and to place these in the forks of trees.*

54. Only seedlings are used for this mode of planting, since they soon form thick tuberous roots and thus become more fit to combat with the comparative dryness to which they are exposed in the tops of trees in the dry season.

55. The first of these were planted on the 25th of January in trees near the nursery, and on the 21st of April they looked everything that could be desired.

56. This mode of planting wood only necessitate a small bridle path being opened through the forest instead of lines 40 feet in width, and is estimated to reduce the cost of the creation of caoutchouc plantations on a large scale, including survey,

* This system was first suggested by Dr. W. Schlich in January 1873, and advocated by him ever since.—THE EDITOR.

formation, conservation, roads, buildings and salaries, from Rs. 10 to Rs. Rs. 5 per acre.

57. The only objection to this plan is the difficulty of inspection, and without constant examination of the plants no satisfactory results can be reckoned on.

This I hope to overcome by having every line numbered, and every tree on which a caoutchouc plant has been placed, marked.

These lines will then be regularly gone over at least once in two months, and the result placed on record in the plantation journal.

After a year or two the plants will be sufficiently large to render the climbing of trees unnecessary, which latter will be the only difficult task in the examination of the plants, but it is considered of such importance during the first year or two, as to justify high pay to the men who have to do this work.

58. It is hoped to bring during these rains 50 acres under cultivation in this way, and thus to obtain results on as early a date as practicable.

59. This mode of growing *Ficus elastica* it is intended to introduce only on the ground of economy and the growing scarcity of labour, and not because it is believed that this tree grows naturally as an epiphyte only, for trees which germinated on the ground are said to be not at all rare in the Akha hills north of the Charduar plantation, and the caoutchouc collectors who go beyond the British boundary into these hills, will have it that such trees, although few in number, grow larger than those which commenced life as epiphytes between the branches of other trees.

Ficus elastica grown in the soil.

60. I myself have never seen but one tree which had undoubtedly germinated on the ground, but then the want of light in the dense forests along the foot of the hills renders it impossible for trees to grow in this way as proved by our seed experiments.

61. The only one specimen above mentioned which ever I saw had a true stem, cylindrical in shape and measured 16 feet in girth 30 feet above the ground, but this had not prevented

the tree from throwing out great numbers of aerial roots descending from branches 50 feet above the ground.

Some of these aerial roots measured 6 to 8 feet in girth at distances of 20 feet from the stem, and had established themselves firmly in the ground like the tree itself.

62. Neither does *Ficus elastica* in Assam, if planted in the ground, remain smaller or more destitute of large aerial roots than trees which grew first as epiphytes, as has been stated.

63. The measurements given below will show that the epiphytic growth of a *Ficus elastica* is not by any means essential, for after all is done and said this tree is only epiphytical in early life for a comparatively small number of years, after which it has its roots in the ground like any other tree.

64. Natives will have it that the aerial roots of young *Ficus elastica* in the Charduar reach the ground in the third year.

65. To corroborate the above, and to ascertain the distances at which the young caoutchouc trees should be planted, enquiry was instituted regarding the age of the largest tree planted in Tezpur, and measurements made of this tree, which were as follow :—

Age of tree	32 years.
Height of tree	110 feet.
Diameter of crown	140 „
Circumference of the centre mass of aerial roots surrounding the stem ...	70 „
Distance of outermost aerial roots from stem	30 „

There were over a hundred aerial roots, the five largest of which measured each respectively 6 feet, 4 feet, 4 feet, 3½ feet and 3 feet in girth, 5 feet above the ground.

66. *These measurements show the size and rapid growth of Ficus elastica* planted in the ground in Assam, which in the forests at the foot of the hills must be even much greater than in the station of Tezpur, and is not less than that of the epiphytic trees.

Distances for planting.

67. As the roots spread out in the soil very near the surface to a distance of 150 feet and more, and form a thick network, it is considered

close planting will seriously interfere with the free development of the roots and growth of the young caoutchouc trees, and unless vigorous growth is ensured no yield of caoutchouc can be expected.

68. It is however intended to have the trees on all the area at present under cultivation planted at 25 feet distances in the lines instead of 50 feet, so as to have a number of young trees available for experiments in tapping to ascertain the yield from young *Ficus elastica*. It is thus intended to have every alternate tree killed by tapping at the time they begin to interfere with the growth of those it is intended to let grow to maturity.

69. The tree measured in Tezpur is exceptionally large, and to all appearance not only healthy but luxuriant, but for all this it yielded next to no caoutchouc when permission was given by the proprietor to one of the traders in the bazar to tap it.

70. This latter fact I do not attribute, as Dr. Schlich, the Conservator of Forests, Bengal, and Dr. King, the Superintendent of the Calcutta Botanical Garden, do, to the fact of the tree having originally been planted in the ground, but to the locality in which it grows, which will be further remarked on under the head of yield of *Ficus elastica*.*

Selection of localities for plantation.

71. The above fact of this luxuriant tree in Tezpur not yielding any caoutchouc, and similar results of experiments in tapping trees in Gauhati made by me, point to the great necessity for a most careful selection of the localities for caoutchouc plantations, and no greater mistake could possibly be made than to start plantations of *Ficus elastica* in any part of Bengal with the view of

* This remark of Mr. Mann's is not quite correct. In the report to which Mr. Mann refers here, Dr. Schlich states that the two most important points are—

1st.—The way in which the tree has been reared, whether as an epiphyte, or from a cutting or seedling reared in the ground; and

2nd.—The greater or lesser moist dampness of the climate.

After stating that he considers the epiphytic trees as likely to reach larger dimensions and to have more and larger aerial roots, and to be consequently more capable of yielding India-rubber, he continues: "Although *Ficus elastica* will grow in the dryer "parts of Bengal, still to ensure its growing luxuriantly and its being able to spare "surplus milk for rubber, it is necessary that it should vegetate in a warm, moist "atmosphere, such as is found in Assam and Sikkim, especially along the foot of the "hills and in the side valleys up to an elevation of 1,500 and perhaps 2,000 feet. "Moreover it appears to me that the aerial roots will only reach the ground and attain "a good size where the tree grows really luxuriantly. To sum up then, I am of "opinion that it would not pay to rear *Ficus elastica* in Bengal, except in warm, moist, "localities, especially in the moister parts of Assam; and, secondly, I have very serious "doubts, whether trees reared in the ground will ever yield a large return, even if "planted in the natural home of the tree."—THE EDITOR.

producing caoutchouc, as suggested by Dr. Henderson, or to draw any conclusions regarding the way it should be cultivated from the appearance of trees planted in Bengal, for although the trees will grow in any part of Bengal, caoutchouc there would be next to none.

72. To insure a sufficiently large area of land being maintained as forest for caoutchouc plantations, proposals for the reserving of an area of about 140 square miles in the Charduar, north of Tezpur, were submitted in spring 1873, and are now under the consideration of the Chief Commissioner.

73. Experiments of planting *Ficus elastica* on a small scale in grass land are carried on by order of the Chief Commissioner in the neighbourhood of Tezpur, to obtain results hereafter regarding the yield of caoutchouc from trees in this locality, as compared with the yield from trees at the foot of the Himalayas.

74. Ten acres were thus brought under cultivation by planting at distances $25' \times 25'$, no vacancies exist, and the plants, though small as yet, look very healthy.

75. Nahor *(Mesua ferrea)* has been planted between the young caoutchouc trees.

76. Close planting in this case is resorted to, to bring about on as early a date as possible a perfect cover on the land and thus extirpate the grass, insure the formation of vegetable mould, the moisture of the soil, and the surface sufficiently open to atmospheric influences, which conditions are insured in the Charduar plantation by leaving part of the forest standing.

Conditions required for the growth of *Ficus elastica*.

77. The general conditions for the healthy and rapid growth of the young trees of *Ficus elastica* as detailed above are these:—

(1*st.*)—Perfect drainage about its roots and looseness of soil so as to admit the air readily, the geological composition of the soil not affecting the trees as long as the above conditions are fulfilled, but it should not be gravel or sand, since all caoutchouc collectors state that it produces much smaller quantities even in the best localities.

(*2nd.*)—Plenty of light without decreasing the moisture of the air by the admission of it.

(*3rd.*)—Heat and moisture combined, or what is commonly termed a close and steamy atmosphere.

78. The districts in Assam suited for caoutchouc plantations are—

1. The Darrang district.
2. The Naga Hill district.
3. The Lakhimpur district.

79. The south of the Cachar district would be suited, but the comparatively unsettled state of the Looshai boundary would not render such a measure for the present at least advisable.

80. None but the moist evergreen forests along the foot of the mountains should ever be chosen for caoutchouc plantations.

81. In the Kulsi plantation no separate establishment has been entertained for this particular work, but the caoutchouc plantation is debited with one-fourth of the cost of the whole plantation establishment.

82. The area of the caoutchouc plantation at the Kulsi at the end of 1873-74 was 35 acres, on which an expenditure of Rs. 377·13, or Rs. 10-12-8 per acre, had been incurred up to that date.

The area got ready for planting last year at the Kulsi is 30 acres, which, together with improvement and conservation of the plantation of 1873-74, cost, during the financial year 1874-75, Rs. 605-14, or Rs. 15-2-1 per acre for two years, which has become so high on account of the nursery, the greater part of which, and especially the seed nursery, was destroyed by floods last year, and the great difficulty in procuring suitable branches for cuttings in this locality.

Establishment, area, and cost of the Charduar caoutchouc plantation.

84. The establishment entertained at the Charduar caoutchouc plantation, including the small experiment near Tezpur, was the following :—

1	Mohurir on Rs.	14	per mensem, for	9	months.
1	,, ,,	20	,, ,,	2	,,
1	Watcher on ,,	7	,, ,,	9½	,,

85. The area of the caoutchouc plantation at the end of 1873-74 was 180 acres, on which an expenditure of Rs. 415-3-6, or Rs. 2-4-10 per acre, had been incurred up to that date.

86. The area planted in 1874-75 was 10 acres near Tezpur, and 140 acres have been got ready for planting at the Charduar plantation.

87. In addition to this, all the lines of last year's plantation have been opened out to double the width, bridle paths been opened out along each line, the plants been fenced in, and large nurseries for cuttings and seedlings been prepared, the cost of which, during the financial year 1874-75, was in the abstract as follows :—

	Rs.	A.	P.
Demarcation	43	11	0
Formation	2,084	3	0
Protection from fire	24	12	0
Improvement and conservation ...	505	6	3
Fencing and enclosing	193	9	6
Roads and bridges	205	10	0
Buildings and offices	607	2	0
Salaries	232	10	0
TOTAL ...	3,896	15	9

or Rs. 13-1 per acre for two years, which is also above the average cost on account of buildings, roads and bridges, as well as the large nurseries which had to be prepared at starting.

88. For all this the cost of the caoutchouc plantations, even at Rs. 10 per acre as now estimated, is very small compared with other plantations.

89. The cost per acre if planted in baskets to be placed in trees is estimated at Rs. 5, but as the experience gained in the latter mode of planting is as yet small, this estimate must be considered subject to correction hereafter.

Supervision of the caoutchouc plantations.

90. The head-quarters of the divisional forest officer in the Gauhati division are on the Kulsi plantations, and that of the officer in charge of the Tezpur division, at the Barolighat, a distance of 5 miles

from the Charduar plantation, so that in either case competent supervision throughout the year is given to this work.

III.—Yield of *Ficus elastica*.

91. Amongst the different conditions on which the yield of the *Ficus elastica* depends stands foremost the locality in which it is grown.

Yield in different localities.

92. When first enquiring in 1869 from the caoutchouc collectors into the yield of the tree in different localities, I was informed that it would yield most in the hills, next best immediately at the foot of the mountains, and that this yield diminished according to the distance from the hills the caoutchouc tree was growing in the open country or even on the banks of the Brahmaputra, where, I was informed, it would yield little or none.

93. It was in accordance with this information that the Charduar plantation was started as being in one of the most favourable localities in Assam.

94. Subsequent and frequent enquiry has been made on this subject, and the collectors now say they get more at the foot of the mountains than in the hills.

95. Whichever is the correct statement, the difference in quantity yielded by trees growing in the plains along the foot of the mountains and those growing on the lower hills is but trifling, if not entirely imaginary, whilst as the forests along the foot of the mountains are left and the open country is entered, the quantity diminishes very rapidly until on the banks of the Brahmaputra, in the stations of Tezpur and Gauhati, as mentioned above, trees which had not been tapped before were tapped without yielding any caoutchouc worth speaking of, thus substantially proving the above information to be correct.

96. The next question raised during the last year is, will *Ficus elastica* yield equally if tapped from the stem or aerial roots? On this point, in Assam at least, no doubt ever existed.

Yield from stem and roots of *Ficus elastica*.

The collectors state that there is no difference whatsoever, but that if they dig up the ground and thus get at the roots in the ground, that the latter will give more.

97. My own observations are that caoutchouc collectors will go to the utmost extremity of the branches at the risk of their lives to procure caoutchouc, and that the quantity will only vary according to the place first attacked ; if this is commenced at the upper branches the greater quantity will be obtained from there; if at the roots in the ground, as, I regret to say, is done in the most cases, the largest quantity will be obtained from these.

98. I have always looked on the formation of aerial roots as one of the greatest advantages in favour of the cultivation of *Ficus elastica*, since the facility with which these are thrown out enables this tree to recover itself much faster than other caoutchouc trees with only a single stem.

99. I do not wish to affirm by the above remark that I do believe in surplus milk, or that a vigorous tree receives through one stem less sap than through many stems; on the coutrary, a tree in health will always produce as much sap as it requires, no matter if through one or many stems or roots, but if by tapping the actions of roots or stem are interfered with or rendered impossible, *Ficus elastica* will, by making new roots, adjust this quicker than a caoutchouc tree with a single stem only.

100. On the other hand, the great number of aerial roots enable the collector to overtap a *Ficus elastica* more than any other caoutchouc tree, as the surface exposed is greater, but this can be easily controlled in the plantations when the trees are ready for tapping.

101. If the *Ficus elastica* is planted in the ground, or germinates in the fork of a tree, it makes but little difference to the size or number of aerial roots formed after, especially if grown as is done in the Charduar plantation, where part of the forest is left standing between the lines of caoutchouc trees, by which an excessively steamy atmosphere is ensured: in such localities the aerial roots will always correspond in size and number to the size of the tree.

102. A single stemmed *Ficus elastica*, without any aerial roots of large size has never been seen by me in Assam, except in stations where every boy takes a pleasure in hacking about the tree, wherever he can get at it.

103. The size, which *Ficus elastica* will reach if planted in the ground (in Assam) has been exhibited in the measurements given above of the oldest planted tree in Tezpur.

Yield per tree of *Ficus elastica.*

104. After a year or two when the natural trees in or about the Charduar plantation have recovered, we shall be able to collect accurate information as to the yield per tree.

105. The information we have about the yield of trees and climbers producing caoutchouc in other parts of the world is so vague, that even after we have ascertained the yield of *Ficus elastica* we shall not be able to draw comparisons.

106. It has been stated that a tree of *Castilloa,* 18 inches in diameter, will give 20 gallons of milk; this certainly *Ficus elastica* will not give, but I must admit that my knowledge of vegetable physiology does not permit me to believe this of *Castilloa* either, at least not oftener than once.

107. As to the *Urceola elastica* yielding caoutchouc in the third year, *Ficus elastica* will do this also, but for all that I consider it would be very imprudent to tap trees before the age of 20 years.

Time for tapping.

108. The most favourable time for tapping certainly is January, February, and March, when the milk runs abundantly, and is superior to that collected in the rains.

Varieties of *Ficus elastica.*

109. There are two varieties of *Ficus elastica,* the "Bogi-Bur," and the "Shika-Bur," and the former of which is said to be slightly superior, but the difference is not such as to render it advisable to confine planting to this variety only.

Manufacture and collection of caoutchouc.

110. There is no doubt room for improvement in the manufacture and collection of caoutchouc, and experiments have been started with a view to ensure this.

111. The task which forest officers in Assam have set themselves to perform, however, is in the first instance to propagate and grow *Ficus elastica,* which has been done most successfully so far, considering the past year was only the second year of these experiments, and the manufacture of superior caoutchouc

will be tried during the coming season as far as the exhausted state of the trees permits.

The Cachar climber yielding caoutchouc.

112. The climber in Cachar giving caoutchouc was searched for and examined; good botanical specimens could not be got at the time, but it is hoped will be procured during the coming year.

The quality of the caoutchouc is extremely inferior, there being no elasticity at all in the substance.

The Eucalyptus Globulus.

From a botanical, economical and medical point of view; translated from the French of J. E. Planchon, Professeur à la Faculté de Montpellier.

BY J. L. LAIRD.*

IN those parterres which are one of the most recent attractions of Paris, at Monceaux the Luxembourg or in the Squares, the visitor may have remarked a strange shrub of peculiar form and color. It looks as if covered with a white powder, or rather with a glaucous bloom; four vertical rows of flexible branches, furnished with ovate, entire, opposite and sessile leaves, protrude horizontally all along its stiff straight stem. Reduced to the modest proportions of 16—20 feet, the *Eucalyptus globulus* is, indeed, nothing more than a novelty among innumerable other horticultural curiosities. It has been taken from a hot-house, and to a hot-house it will have to return before the beginning of winter; or, as is oftener the case, it will be pitilessly sacrificed to make way for younger trees, which, after being born in spring, pass the following winter under cover, are then planted out, completing the period of their *infancy* before the end of autumn. Thus, by the inclemency of the climate and man's caprice, the colossal dimensions of a giant of the vegetable kingdom are represented by a shrub, and its life confined to the short space of two years.

Even in Europe—wherever the orange flourishes—the rapidity of its growth is unequalled; but, to see gigantic trees, it is necessary to visit the Australian home of the Eucalyptus.

Wherever, in our hemisphere, winter is only a happy compromise between a prolonged summer and early spring, Australian plants, true to their natural mode of life, bud and grow from October to March; but the Eucalypti, more particularly when transported to Algeria, Corsica, or the mild climates of Provence and Nice—where they introduce a picturesque element in the scenery, and promise to become an important source of forest wealth—grow almost uninterruptedly and with marvel-

* This paper contains many parts, which might have been omitted in reprinting it in the I. F., but as that would have destroyed the connection between the different sections, the Editor considered it preferable to give the whole paper.—THE EDITOR.

lous rapidity. The scent they emit is of recognized utility in hygiene, and has even been found useful in cases of intermittent fever. The Eucalyptus has further been useful in correcting the unhealthiness of marshes, and is, perhaps, the most important vegetable importation of our century.

Public attention has been directed to all these useful qualities, and we will endeavour, without losing sight of the practical side of the question, to give prominence to the scientific point of view, which, for several reasons, is of peculiar interest.

I.

The vast genus *Eucalyptus*, rich in more than 150 species; is typically Australian, that is to say, it bears the stamp of a country, the products of which are the most original in the world; a country where the swans are black, where mammals, such as the Ornithorhyncus and Echidna, are closely allied to the birds, and regarding the vegetation of which the late Abbé Correa de Serra exclaimed, "Flore au bal Masqué." And many plants seem, in reality, to bear a mask, so remarkable is their mimicry of other forms. Here, *Proteaceæ* assume the guise of ferns; there, legions of Acacias, far from displaying the pinnate foliage of the Mimosa, resemble the juniper or the willow. The Eucalypti do not escape this tendency to mimicry, and, strange to say, the same species is often different at different stages of its existence; these remarkable instances of heteromorphism are of frequent occurrence in Australia, and their philosophical bearing with reference to the theory of the origin of species is, perhaps, not yet thoroughly appreciated.

When young, *the Eucalyptus globulus* has, as we have seen, opposite, sessile and glaucous leaves, and somewhat resembles a myrtle or, perhaps, a frutescent St. John's Wort. But the shrub becomes a tree, and all is changed. New branches, no longer opposite but alternate, are thrown out; the new leaves, also alternate, have lost the ovate shape, and are lengthened and recurvate; their colour, too, has changed from glaucous to pale green, and, instead of being sessile, they are attached to the branches by slender petioles. The likeness to a myrtle has also disappeared, and the tree is now more like a willow. This

dimorphism, which is of frequent occurrence, gives a monotonous uniformity to the vegetation of Australia. Sparse pale foliage, often dazzling and of a dry, coriaceous texture, with drooping branches, is the well-known characteristic of Australian forests, which consist principally of Acaciæ and Eucalypti, and present a melancholy appearance whenever the flowers are wanting.

There are two well-defined periods in the life of the *Eucalyptus globulus*. During the period of *infancy*, when the leaves are opposite and sessile and the plant does not bear fruit, it is, so to say, in a *larva* state; the *adult*, or perfect state, being characterized by alternate and petioled leaves and the presence of flowers and fruit. We must, however, be careful not to continue the analogy too far, by comparing the dimorphism of the Eucalyptus with the metamorphoses of insects; with the changes, for instance, of a butterfly, which becomes successively a caterpillar, a chrysalis and a butterfly. In the latter case, the individual deprives itself of successive envelopes and becomes changed through internal processes and modification of the same organs; in the case of the Eucalyptus there is, properly speaking, no metamorphosis; all we can affirm is, that certain organs are superadded; in other words, the tree does not represent an individual, but an assemblage of foliaceous elements, of which each successive individual may have a peculiar form, different from either that of its predecessor or from that which follows. The similarities, or differences, between such elements do not affect their individuality; in short, there is polymorphism, but not metamorphosis in the strict sense of the word.

This polymorphism is not, however, a general characteristic of the genus. It is wanting in a certain measure in species, which, like the *E. cordata*, bear flowers on branches with opposite leaves. In such cases, the adult and infantile states are merged, and, without attaching much importance to the analogy between animals with centralized functions and plants with multiple elements, we may perhaps be permitted to compare the infantile and adult states of dimorphous Eucalypti with the tadpole and adult states of common batrachians (frogs, salamanders), while Eucalypti, which flower on infantile branches would be comparable with the so-called perennibranchiate batra-

chians—*Protei* for instance—which reproduce themselves sexually and yet preserve their branchial respiration.

But apart from this analogy, it is a remarkable fact that there are two kinds of flowering in some trees and only one in others. Now, supposing that, from some unknown cause, a Eucalyptus of the first group were to bear fruit on branches with opposite leaves, there is no reason to suppose that the seeds would not reproduce, in germinating, the characteristics of the plant from which they were derived, and that nature would not thus form a simple but permanent variety, the equivalent of what is every day described as a new species; in other terms, if the habitually sterile branches of an *E. globulus* were found bearing fruit, would not the plant constitute a new type, and, if met with alone and unconnected with its starting-point, be described as a new species? And who can say that many species, supposed to be genuine and accepted as such, are not derived from living or extinct types. This is, it is true, merely a hypothesis; but it is easily conceivable that the two forms which are seen in similar elements of the same plant, might, under favourable conditions, become permanently separated, and thus form new and distinct species.

I do not pretend to solve the complex problem of the origin of species; still, I find in the facts stated an argument *a priori* in favor of the theory of descent, as opposed to the theory of the absolute immutability of species; but let us descend from the somewhat misty regions of philosophic speculation to the field of facts concerning the *Eucalyptus globulus*.

Its discovery recalls to mind one of the great voyages of the old French navy. Nothing had been heard since 1788 of La Pérouse, and the National Assembly very properly resolved in 1791 to send a party in search of the unfortunate navigator. The command of the expedition was given to the Chevalier D'Entrecasteaux a sailor of the good old school and worthy follower of de Suffren. The two ships, the *Recherche* and the *Espérance*, carried a group of savans, amongst them the botanists Labillardière and Riche. The latter died of fatigue and grief at the loss of his collections, but the former brought back from Australia and Van Diemen's Land valuable materials,

which formed the basis of important publications. In his account of the voyage are to be found the details of the discovery of the Eucalyptus and the sagacious prediction that the tree would one day be used in ship-building. We will now quote from the naturalist's journal:—

"12*th May* 1792—The expedition was then in Port D'Entrecasteaux, Tempest Bay, Van Diemen's Land.

"I had been unable to procure a new Eucalyptus, which had remarkable fruit somewhat resembling a button. The species, which only bore fruit near the top, was one of the highest trees on record, several specimens being estimated at half a hectométre (164 feet) in height. The stem might be used in ship-building, perhaps for masts, although neither as elastic nor as light as pine. Perhaps it might answer for the latter purpose and be more pliable, if spliced, or even if split up the centre and the trunk strengthened by bands of iron. * * *

"We were at last obliged to fell one of the trees in order to procure the flowers; the felling was, however, quickly effected as the tree was much inclined. When falling, a quantity of sap spouted out of the lower part of the stem.

"This beautiful tree, which belongs to the Myrtle Family, has a rather smooth bark and gyrose branches, furnished at the extremity with alternate and slightly falcate leaves about 8″ by 2″ in size. The flowers are solitary and rise from the axils of the leaves. The bark, leaves, and fruit are aromatic and might serve, if necessary, as substitutes for the aromatics now imported exclusively from the Moluccas."

Labillardière also mentions that the wood of the *E. globulus* was used in repairing the launch; a modest beginning, but a prelude to its employment on a large scale in the construction of vessels.

For a long time the *Eucalyptus globulus* only excited the curiosity of a few botanists. It had even grown unnoticed in the Botanical Gardens, for, in 1854, I discovered a plant under the name of *E. glauca*, in the Conservatory of the Museum of Paris. Others were growing about the same time in M. Demidof's green-house at San-Donato under the name of *E. falcata*, and the horticulturists, Cels and Noisette, had cultivated some in

1822 and 1824, respectively, without knowing what they were. England, so rich in her collections of Australian plants, had paid no special attention to this tree as a garden plant, probably because when young its appearance is but little different from other well-known Eucalypti. The colonists of Tasmania, on the other hand, thoroughly appreciated their magnificent *blue gum*—as they called it—and employed it for various purposes; but, before this tree, confined to a remote corner of the world, was destined to form colonies far and wide, a chain of circumstances was necessary, of which the first link was forged scarcely forty years ago. These events were the foundation of the colony of Victoria; the building and marvellous development of a large city in a desert region, where the thirst for gold was to prepare the way for more real wealth, the result of the utilization of the pasture; further, the formation of a beautiful park in the hastily-built city of Melbourne, and, lastly, the exertions of two men, Von Müller and Ramel, who will always be remembered with gratitude wherever the Eucalyptus is a source of public wealth. In the history of the spread of the Eucalyptus, Von Müller is the man of science who carefully calculates the prospective value of the tree and predicts its destiny; Ramel is an enthusiastic amateur, who enters, heart and soul, into the work of propagandist. Both have faith; but the one is a prophet, the other an apostle. Hereafter, their respective rôles will be forgotten, and, as the army of Egypt spoke of Monge-Berthollet, so will the names of these two men be inseparably connected as Müller-Ramel in the minds of the people.

II.

One of the first things the English do after they have established themselves in a new country, is to make a public garden. What we have done at Bourbon, Pondicherry, Guadeloupe, Cayenne, Algiers, Saïgon, our neighbours have done on a large and magnificent scale at Calcutta, the Cape, Sydney, Ceylon, and on a minor scale at smaller stations where politics or commerce has given them a footing. Such gardens become, from the date of their foundation, fields of useful experiments on indigenous plants and exotics procured by exchange. Thus in

1832 complete collections of the vines of Luxemburg and the *Jardin des Plantes* were cultivated at Sydney. In this way the acclimatization of the vine was shown to be possible, and its cultivation soon spread in New South Wales, and still more rapidly in the more southern colonies of Victoria and South-Australia. In 1861, these two provinces alone had 1,000 hectares (2,469 acres) of vines, which already gave promise of becoming a new source of wealth. In the same way those centres of quinine-cultivation, Darjeeling, Ootacamund and Akgalle, are the offspring of the gardens of Calcutta, Madras and Peradenia. Thus the Peruvian barks, which are being gradually exterminated in Spanish America, are methodically exploited in the English and Dutch Colonies of India and Java, where the climate is even better adapted to their growth than that of the Andes.

Without insisting further on the advantages to be derived from colonial gardens, where botany assists and not unfrequently initiates—a fact too often forgotten—all kinds of culture, we may mention the Melbourne gardens as a case in point, there all vegetable productions of temperate regions have been experimented on, and there the most progress has been made in the study of the Australian Flora. Melbourne has also furnished all the botanical gardens of the world with seeds of living plants, some of purely scientific interest and others of economic importance.

It may not be inappropriate to say here a few words on the subject of acclimatization. The term seems to be used to express a change of country imposed by man on non-migratory plants. But the word, as it is generally conceived and as defined by dictionaries and etymology, implies an ignorance of nature and, if we may venture to use the term, of the constitution of plants. Animals, although the degree of resistance of some is very great, and although domestic species are in a certain measure protected by man in unsuitable climates, do not become acclimatized singly; selection alone, either natural or artificial, unconscious or premeditated, can effect a sorting of individuals of different constitutions so that those best adapted to the new conditions survive and the rest succumb; afterwards the law of heredity comes into play and gives to the survivors at least some of the resisting power

of their progenitors, which becomes fixed and gradually increased by reason of the natural tendency of the species in this direction. The final results of these gradual modifications, which are generally confined within very narrow limits, are better defined by the word naturalization then by acclimatization. The species, in becoming naturalized, is modified so as to adapt itself to the new environment. Individuals can only become inured by avoiding sudden transitions; man effects this object by clothing, by artificial heat and other means, which plants, fixed as they are to one spot and exposed to all kinds of weather, obviously cannot employ. Admitting, therefore, that man is acclimatized, and that through his care some animals adapt themselves to new conditions, we would prefer saying that plants are introduced or naturalized; but this adaptation, if real, is in any case slowly effected by the selection of successive generations resulting in the creation of new races, or local varieties more pliable in regard to climate and environment. An illusion, now past, led gardeners to believe that tropical plants would be able to live in temperate or still colder zones if, after being raised in green-houses, they appeared capable of withstanding sudden exposure. This was the case with the Mexican dahlias; but then two circumstances were forgotten:—

Firstly, that they grow in a comparatively temperate climate, considering that the slightest frost is just as injurious to them to-day as during the first year of their introduction. "Acclimatation, douce chimère des jardiniers!" says, Aubert Du Petit Thouars; and this verdict of an able botanist is the final condemnation of a specious, but equally false theory.

We are far from wishing to deprive those most useful societies of their title "Acclimatization Society," which they have inscribed on their colours; but it is well to forewarn the public of the error hidden behind an apparently innocent epithet. It was owing to an imaginary adaptation of this kind that a serious proposal was made to Government to grow tea and even cinchona in Algeria. It was thought that the problem to solve was merely one of temperature; whereas, as far as regards climate, much more important questions than either the absolute or mean tem-

perature, are the distribution of heat according to seasons and, more particularly, the balance between heat and atmospheric moisture. If we consider the latter question, we can then easily understand how it happens that Indian camelias, azalias and tea-plants are not injuriously affected by a moderate amount of winter-cold, and yet require during hot weather a moist atmosphere, the vapours of which protect the plants from direct solar heat. These conditions are more nearly reached in Western France, where there is a great deal of rain and fog in summer, than under the more southern sky of the Mediterranean sea-board and mountains of Algeria, where the summer is dry. It is not improbable that, if tea-cultivation on a large scale does not succeed at Brest and Cherbourg, its failure is partly, or entirely, owing to insufficient summer heat.

In order to naturalise a plant with any hope of success, it is necessary that the new climatic conditions should be somewhat similar to the old. To rely on a sudden change of climate would certainly be a mistake, unless, indeed, it was evident from modifications in the character of the vegetation that the climate was changing; to expect the nature of the plant to change would be still more absurd. The proper method to follow, both in theory and practice, is to consult nature, to study the climate, and to draw conclusions accordingly as to the probability of naturalizing such and such a plant; then experiments should be made with a view to finding out the conditions best suited to the species in its new home. Such complex problems cannot be solved *a priori*; a number of facts must be first of all collected, and it is easy to overlook one, which may be sufficient to cause the failure of the most promising undertaking.

At first sight, it would appear probable that if plants of one region are easily naturalized in another, the converse would also hold good, and plants of the latter region be easily naturalized in the country of the former. There is no greater mistake, and botanists know the reason well. Wild and cultivated plants of Great Britain have been introduced in great numbers into Australia, and most have already become noxious weeds, but not one single Australian plant has yet propagated itself in England,

excepting in ornamental gardens, where Australian plants have been cultivated by thousands. The English winter is assuredly not the only obstacle to the naturalization of Australian plants; it would spare, at least, annuals and those which reproduce themselves yearly by seed, and the obstacle should be sought for in internal conditions, such as the requirements and mode of life of each plant, rather than in purely climatic conditions. Some types are essentially migratory, spreading wherever the climate does not impose a veto on them; the characteristic of others is essentially sedentary. The former are aggressive, and even noxious to the indigenous vegetation; the latter, confined to a relatively small area, are exposed to, and unable to defend themselves against the attacks of man and imported animals (goats, rabbits, etc.), and are even subjected to a fatal competition with strange plants. This is the reason why, in our day, some species of the Mallow Family of St. Helena, peculiar to the island, are gradually disappearing under the combined actions of man, sheep and Australian Acacias.

But, to return to our subject, M. de Candolle distinguishes several kinds of naturalization. In an absolute sense, a plant is not naturalized until it can maintain itself alone in its adopted country, pass successfully several years of extremes as regards climate, reproduce itself by seed, and, in short, compete unassisted with indigenous species. Every plant which, after being repeatedly introduced into a country, fails to maintain itself is simply *adventive.* Others, which only reproduce themselves from stools, as is the case with the sumac-tree of Japan, are only half naturalized, or, more properly speaking, the individuals are naturalized but the species are not, for, continued and spontaneous reproduction by seed is the criterion of naturalization. Comprised in these two categories are two others: that of plants which follow in the footsteps of man and domestic animals, never leaving their dwellings or their fields (harvest plants), these are, in reality, strangers which have been admitted as a privilege to a corner of the domestic hearth, but to whom an independent life is denied; then there are cultivated plants properly so called, either

domesticated or wild, which cannot maintain themselves in a foreign country unless carefully protected by man.

The Eucalyptus belongs at present to the latter category, as far as concerns its naturalization in the extreme south of Europe and Northern Africa, where the tree has been introduced and extensively cultivated but, although well suited to the climate, not yet naturalized. De Candolle's distinctions are, however, of little consequence, if the practical result remains the same, and there is no reason why this beautiful tree should not some day reproduce itself spontaneously. In the meantime, as we cannot follow it in its voyage round the world, we will endeavour only to trace the history of its recent introduction into Provence, the Maritime Alps, and more particularly Algeria.

The principal supporters of the Eucalyptus are Baron v. Müller and Mr. Ramel, the former naturalized Anglo-Australian, but a German by birth, is a naturalist and traveller, and has especially distinguished himself by his botanical researches *in Australia. He has been for more than twenty years* Curator of the Botanical Gardens at Melbourne, which he has constituted one of the largest depôts in the world for the exchange of plants. He is a clever writer and indefatigable collector, and has described all the economical resources of Australia, both in indigenous and exotic plants, and has further done his best to enrich other lands with the natural productions of his adopted country. In this generous endeavour, he has been ably seconded by our countryman, Mr. Ramel. Of an ardent disposition, and imbued with unswerving faith in the future he has pictured, M. Ramel has become, almost by chance, a patron of the Eucalyptus. In 1854, having gone to Australia on business, he was one day walking in the Botanical Gardens at Melbourne, when his attention was attracted by the elegance and beauty of a blue gum (*E. globulus*) growing in a sidewalk. Being almost a stranger to botany, he neither knew the popular nor the scientific name of the plant; but from that moment the tree became a fixed idea in his mind, and was the means of bringing him into contact with v. Müller and other savans and amateurs. He believed in the Eucalyptus as some believe in the

triumph of good on earth, and had the satisfaction to see it covering the mountains of Algeria, restoring the salubrity of marshlands, driving away fever, and substituting sweet-scented cigarettes in place of the stupifying fumes of the *heshich*. The dream of yesterday has been all but realized to-day ; for, cigarrettes apart, no forest tree has hitherto introduced so picturesque and useful a feature in the scenery of Algeria.

The *Eucalyptus globulus* had been exported to Algiers in 1854 but without any one knowing the fact. In 1863, when visiting the experimental gardens on the slopes of the Saleb, I picked up some seeds of a tolerably large tree which I at once recognized as the *globulus*. This tree had probably been raised in 1854 from the same consignment of seeds as the one I had previously seen in a hot-house of the Paris Museum under the name of *E. glauca*. While this *adult Eucalyptus globulus* flourished unknown on the hill-side, thousands of the same species were to be seen under their proper name in the nurseries of the *Hamma* (an experimental garden). The seed sent from Melbourne by Baron v. Müller and others had been sown in 1861. It was M. Hardy's intention to have distributed the young seedlings throughout the colony; but, before the distribution was effected, a fortunate colonist, M. A. Cordier, applied to M. Ramel and procured a hundred seeds from him in 1862. From these he raised 62 seedlings, which were only 15 centimètres high in May 1863. In the spring of the same year I sent to Mr. Charles Bourlier 12 plants, given to me by a nursery-gardener of Montpellier, and these, too, flourished and grew rapidly. In the same year thousands of the young Eucalypti at the Hamma were distributed all over the country. In the race, M. Cordier maintained the lead, and planted several hectares with the new species.

Soon afterwards, another colonist, M. Trottier, was in his turn seized with Eucalyptus-fever. He, too, had faith in the tree and proved it by planting energetically for others, as well as on his own account. He foresaw its industrial importance in the future, and did not hesitate to take for his motto "The wood of the Eucalyptus will one day be the principal product of Algeria." He went even further, and in his "Boisement

dans le désert et Colonisation," drew a picture of the forest invading the desert, drawing up the subterranean water, and entirely altering the climate of the country. It must be admitted that there is something Utopian in the language of the author, but enthusiasm is worth something when it is necessary to attract public attention to a useful object, and even though the pioneer of a new route is sure to make mistakes, such mistakes serve to guide the prudent and the timid.

However, although the desert is not yet reclaimed, the cause of the Eucalyptus is now fully established in other respects. It has been naturalized on a grand scale, and hundreds of thousands of trees have been planted out, singly or as forest, all over the country, so that a stranger who did not know its *history would take it for an indigenous plant.*

It is, by the way, a curious fact that two plants, to all appearances the most characteristic of Algeria, have been imported since the discovery of the New World. The Indian fig-tree and the American aloe are not only strangers to Africa, but are representatives of two exclusively American families, and if there were no documents to prove their importation, botanists alone would be able to infer the fact from the natural geographical distribution of the families and from the circumstance that they are generally reproduced either from slips or suckers, instead of from seed.

Although the Eucalyptus, like the American aloe and the prickly pear, seem as if created expressly for Algeria, it does not find as suitable a home everywhere on the Mediterranean Coast. In the south of France, spots suitable to the growth of Australian plants are only to be found where the orange flourishes in the open air. Port-Vendres, Callioure in the Eastern Pyrenees, Saint-Mandrier, Hyères in the Var, Cannes, the gulf of Zouan, Antibes, Nice, Villefranche, Monaco in the Maritime Alps are favoured stations, where winter is the flowering-season of thousands of exotic plants. Beyond this zone, the climate of the Olive is too variable to suit the constitution of the Eucalyptus. The clearness of the sky in these parts favours radiation, and sometimes gives rise to frost which destroys in one night the hopes of a whole year; not to mention

the occurrence at long intervals of very low temperatures (down to 17° C. at Montpellier) which kill even indigenous trees (laurel, laurustin, rock-rose, kermes-oak). At Montpellier and Marseilles, and even at Narbonne, experience teaches that the cultivation of Australian plants is extremely precarious. From 1863 to 1870, I experimented with the *E. globulus*, and finally came to the conclusion that its cultivation in the open air in Languedoc, or even Western Provence, can at best only be a partial success and, as far as regards the reboisement and drainage of marshes, can never have any practical results. In Camarague no experiments have been made, but it is more than doubtful that the cultivation of Eucalyptus would succeed in a level, unsheltered part of the country, exposed to the full force of the mistral, and with a vegetation which does not indicate a warmer climate than that of Montpellier. Even on the hill, named *Roucas Blanc*, at Marseilles, where M. Talabot has skilfully protected it under nurses of Aleppo pines and behind rocks, the Eucalyptus is evidently delicate, and although rapid in its growth when young, does not give much hope for the future; moreover, it is liable to be killed by the first exceptional winter.

The Eucalyptus was introduced into Eastern Provence about the year 1854. Since the year 1860 the brothers Hüber have had a typical plant in their garden at Hyères, that is to say, one with a pyramidal crown. The same year M. Gustave Thuret, of Antibes, planted out one in the open, and in 1860 it had successfully withstood the cold of two winters. Some seeds, received from Baron v. Müller in 1860, and sent by me to M. Thuret, were sown in the spring of 1861; in January 1862, the young plants, after a very dry year were 2 to 3·25 mètres (6½—10½ feet) in height. On seeing these plants in November 1863, I could scarcely believe the testimony of my eyes; the seedlings had grown into trees with respectable trunks and an ample crown of flowers. Now-a-days, the traveller from Monaco to Cannes can see during the whole of the journey the erect branches and tremulous leaves of the Eucalyptus contrasting with the pale foliage and venerable trunks of the olive, or with the umbrella-like crowns of the Italian pine.

So far then, we have seen the Eucalyptus established, or at all events naturalized in Algeria and the winter-stations of Nice and Provence. What advantages may we expect to derive from the tree? Many—some evident, others, perhaps, less so, but in favour of which the indirect evidence is so strong that we may safely take them into account without fear of being considered rash. In the sketch we are about to give of the approved and possible uses of the new tree, two points of view present themselves. On the one hand we have the Eucalyptus as a forest tree, on the other its use in restoring the salubrity of marshes, in curing fevers and other maladies, and as an aromatic, not only in medicine but also in perfumery and confectionery.

III.

Many species of Eucalyptus become veritable giants in their own country. "A *Eucalyptus colossea,* called *karri* by the natives, was found to measure," says Baron Müller, "122 mètres (400 feet) and some specimens of *Eucalyptus amygdalina* 128 mètres (420 feet) and even 145 mètres (475 feet). The height of another, not measured, was estimated at 500 feet (152 mètres.) For the sake of comparison we may take the dome of the Invalides 105 mètres high, the spire of Strassburg Cathedral 142 mètres, or the pyramid of Cheops, the highest building in the world, 146 mètres. The *Eucalyptus amygdalina* would, therefore, overshadow the Great Pyramid. The highest Wellingtonias in the district of Calaveras in the Sierra Nevada, only measured 76—98 mètres (249—321 feet). The trunk of the largest measured 8·86 mètres (28·06 feet) in diameter, whereas a Eucalyptus in Tasmania measured near the ground 9·15 mètres (29 feet) in diameter, and 3·66 mètres (12) feet at the intersection of the first branch, which was at a height of 70 mètres (229 feet), the total height of the tree being 91·5 mètres (300 feet). An approximate calculation gives the weight of this tree as 4,46,886 kilogrammes (9,83,150lbs.)*

*According to v. Müller (*Report on the Resources of Victoria*, 1860,) the dimensions of a tree in a valley near Wellington, Tasmania, were: Circumference near the base 29·25 mètres (95·94 feet), at a height of 2·6 mètres (8·5 feet); the circumference was 20·2 mètres (66·25 feet), at 6·8 mètres (22·28 feet), 8·2 mètres (26·9 feet) the approximate height of the tree being 98 mètres (315 feet). Judging from previous measurements the tree must have been 800 years old.

Although it does not attain to such huge proportions, the *E. globulus* is one of the largest forest trees of Australia and of the world. Immense planks have sometimes been on view at International Exhibitions, and one was sent in 1862 to the Exhibition in London, which measured 23 mètres (75 feet) in length and 3·5 mètres (11·48 feet) in width. A plank 51 mètres (167 feet) long was to have been sent, but no ship could be found large enough to carry so cumbersome a burden; the only way would have been to have made the plank form part of the structure of the ship, a purpose to which the wood is now being applied in England, but more particularly in Australia, where its solidity, durability, and tenacity are thoroughly appreciated. "The best South-sea Whalers," writes M. Ramell, "are those of Hobart Town, a place celebrated for its unrivalled keels, which are made of *Eucalyptus globulus*."

The wood of the Eucalyptus combines the qualities, rarely found together, of density and rapidity of growth. The latter is more remarkable during the first few years, but the tree still continues to grow rapidly in height until its 80th year; after this age, the stem, generally very straight, only grows in thickness. Its compact and tough wood resists decay for a long time, even when in contact with salt water, a fact probably owing to the presence of a resinous substance. Like the oak, it lasts a long time in the ground, and is used for railway-sleepers. Its durability makes it much sought after for bridges, piers, viaducts and the bottoms of ships; for piles it is only surpassed by the white oak of Canada, and the only reason why it is not much used in house-carpentry is, that it is too difficult to work and cut up into small pieces. In 1860 the price of a cubic foot at Melbourne varied from 2·5 francs to 3·75 francs (2*s.* 1*d.*—3*s.* 1½*d.*) according to the size of the log.

It is not easy to estimate the prospective value of forests of blue gums raised in Algeria, and an approximation to the truth is all that can be expected, since the calculation is necessarily based on imperfect data. M. Trottier, who is evidently over-sanguine, anticipates for a hectare (2·47 acres) containing 500 blue gums, a nett revenue of 1,200 francs (£48) after 5

years, and of 53,254 francs (£2,130) in 26 years. He gives the prospective yields as follows:—

A hectare	cleared in the	5th	year	produces nett	1,200	Fr.
Ditto	ditto	10th	„	„	5,254	„
Ditto	ditto	15th	„	„	11,708	„
Ditto	ditto	20th	„	„	25,366	„
Ditto	ditto	25th	„	„	53,254	„

In a paper read before the Agricultural Society of Algiers in March 1868 M. Trottier gave his reasons for these figures as follows: A hectare can bear 500 trees. If the plantation succeeds, all these will have a diameter of 20 centimètres (7·9 inches) at 2 mètres ($6\frac{1}{2}$ feet) above the ground by the end of three years. Trees of this size could be sold at the rate of 5 francs per mètre, and the first thinning would yield 2,500 francs. At eight years the remaining trees would be of a size suitable for railway-sleepers and each tree would be worth 20 francs; a hectare would thus have yielded a gross revenue of 6,200 francs. One thing, however, I cannot understand, and that is, how M. Trottier manages to cut, from a total of 500 blue gums to the hectare, a sufficient number after three years to realize 2,500 francs, and yet leave a sufficient number of trees to make 3,700 francs by their sale five years afterwards. In order to do this, it would be necessary to leave 185 standards after the thinning.

Mons. Gumbert's method of valuation is quite different. He takes the value of all the *seed-woods* (*i.e.*, forests always reproduced by seed) of France 4, 137, 995, 228, francs, as a basis. The state cuts seed-woods every 100, 150, or 200 years, the communes every 100, and private individuals, on an average, every 70 years. Assuming that all seed-woods are cut on an average every 100 years, the Eucalyptus would be cut five times during the same period, and the value of the forests would be five-fold. But it is clear that this calculation is only applicable to a very small portion of France, as the blue gum only thrives on an area limited to certain localities of the Mediterranean Sea-board. M. Regulus Carlotti estimates that if a large area in Corsica was planted with blue

gums, there would be a clear profit of 1,295,000 francs in 8 years.

Mons. Lambart, of Algiers, a retired Inspector of Forests, published a book in 1873, in which he gives the value of a hectare of blue gums subject to a revolution of 10 years, as 34,121 francs. "If the regeneration were effected by sowing, the expenses would be 666 for a hectare; if by planting 2,131 francs." His supposed returns are therefore much higher than those calculated by M. Trottier. I give the figures, acknowledging my inability to discuss them.

It is well to compare these statements with the following much more modest calculation of M. Cordier. He supposes, if a thousand trees are planted out as forest and regularly thinned that, after 5 years 500, value 600 francs, could be cut, in the 10th year 250, value 1,313 francs, in the 15th year 125, value 1,473 francs, in the 20th year 60, value 1,521 francs, in the 25th year 60, value 3,195 francs, giving a total of 8,102 francs, and representing for a revolution of 25 years an annual income of about 300 francs. Although this result does not nearly come up to the expectations of certain planters, it represents, a very good profit, and ought to be sufficient encouragement to the colonists to continue planting.

M. Trottier, when estimating the annual growth of the Eucalyptus, based his calculations on the increase of trees at the Hamma, whose mean yearly growth was about 13 centimètres (5 inches) in circumference; but as these trees were planted in line, M. Trotlier thinks a fair rate for trees planted in the forest would be 10 centimètres (3·9 inches), but he forgets that 500 trees could not be maintained for 26 years on a hectare without their injuring each other, and that for this reason periodical thinnings would be necessary. M. Cordier has taken into account the deficit occasioned by such thinnings, hence the difference in the results obtained, in spite of his employing in his calculations the same rate of growth and the same prices as formed the basis of Trottier's estimate. It is not for me to decide who is right; this question must be determined by the practical forester. It can, however, only be solved by an appeal to facts, and much must always depend on

the station in which experiments are made, for results obtained in one particular place are not necessarily true for another.*

Another question to be solved practically is, what stations are best suited to the growth of the trees. As regards soils and with reference to its hygienic utility and rapidity of growth, hot and swampy lowlands seem best suited to the Eucalyptus; but as, according to v. Müller, it is satisfied with poor, dry soils in its own country, the blue gum may perhaps be found useful in reboising the denuded hills of Algeria. It is, however, well not to be too sanguine; out of nothing comes nothing, and plants, even those with the constitution of a camel, cannot withstand the aridity of the desert, unless endowed with the power of drawing up water from considerable depths; as far as we are able to judge, the Eucalyptus seems to be able to resist great draught in summer, but also to derive much benefit from the rains of autumn, winter and spring, wherever the climate admits of uninterrupted vegetation during these seasons.

The almost fabulous rapidity of growth of the Eucalyptus is explained by the admirable continuity in its vegetation. As soon as the roots establish themselves in a fresh and fertile soil, such as is found at the *Hamma*, the mean monthly growth in length sometimes amounts to ·5 of a mètre (1·64 feet). [Hardy]. At Cannes plants one year old, planted out in May, had reached a height of about 6 mètres (20 feet) in the following December; after the third year the rate diminishes; still, it continues sufficiently rapid to allow a tree planted in 1857, as, for instance, that of the Brother Huber at Hyères to attain a height of 25 mètres (82 feet) in 1872.†

IV.

In Valencia the popular name of the Eucalyptus is *fever-tree*, a synonym which proves the general belief in its efficacy as

* I fear that all these calculations are considerably above the returns which can reasonably be expected, if the tree is cultivated on a large scale. As M. Blanchon remarks, only actual facts can decide this point.—THE EDITOR.

† M. Ramel writes to me from Hussein Dey near Algiers, on the 4th May, 1874: "I planted during March and April, nearly 14,000 blue gums. They were planted at 1 mètre (3·28 feet), 1·5 mètres (4·9 feet) and 2·5 mètres (8·2 feet) apart. They are getting on splendidly. I measured one which is 4·2 mètres (13·78 feet) high, with a spread of 3·75 mètres (12·3 feet) and a stem ·25 of a mètre (9·84 inches) in circumference. This particular tree was raised in January from seed and planted out on the 25th March.

an antidote against miasmatic fever. There are two ways of combating endemic diseases of this kind. Firstly, by improved sanitary arrangements calculated to stamp out the evil altogether, and, secondly, by medical treatment. Let us examine the use of the Eucalyptus from both points of view.

It is a well-known fact that countries which abound in primeval forests of blue gums are generally very healthy. Their salubrity might, however, be attributed to the influence of climate; but M. Ramel, giving way, perhaps unconsciously, to a feeling of partiality for his favourite tree, at once attributed this healthiness to the action of the Eucalyptus, an idea which took firm root in his mind. Although the assumption was scarcely justifiable at that time, it was soon strengthened, and finally incontrovertibly proved by the effect of Eucalyptus plantations on the healthiness of marshes in different parts of the world. The first known case of its influence in this respect was at the Cape of Good Hope, where the blue gum is said to have restored the healthiness of certain parts of the country; later on experiments were made in the Spanish provinces of Cadiz, Seville, Cordova, Valencia and Barcelona, where the blue gum was introduced in 1860 by the Acclimatization-Society; further proof is furnished by the reclamation of unhealthy swamps in parts of Corsica and Algeria. The evidence regarding the influence of the Eucalyptus is all the more reliable as having come from able physicians, more particularly Dr. Carlotti.

The healthy action of forests of Eucalyptus may be explained by a combination of two causes: the influence they exercise by absorbing moisture and exhaling it from the leaves, and that caused by volatile substances given off by the aerial parts of the tree. These emanations, of which the basis is an essential oil, act, perhaps, on the constitution as a stimulant, in the same way as the scent emitted by pines is known to benefit the health or even to cure certain diseases of the lungs, and to act as a tonic in cases of debility. M. Gubler thinks that these volatile substances may even neutralize or destroy the unknown germs which seem to be the cause of miasmatic fevers, and which consist, according to some authors, of microscopic *Algae*, and, according to others, of Animalculæ. Practically it does

tannin of its leaves acts as an astringent tonic, and its essential oil as a stimulant. The leaves, if applied to wounds, promote the process of healing, and when infused, weak doses act as a healthy stimulant in place of tea. Properly understood, the Eucalyptus is useful in certain diseases of the lungs, and M. Ramel recommends, with a confidence which we would like to see justified, the use of Eucalyptus-cigarettes, which are said to have afforded relief to Trosper Mérimée in his last illness when suffering from asthma.

The chemical uses of the blue gum can only be lightly touched upon in a sketch from which all technical details are excluded; all these may be found in the works of Messrs. Taillotte and Höckel, who also give the chemistry of the different substances extracted from the tree. The most interesting of these is the *Eucalyptal*, a volatile product extracted in 1870 by M. Cloëz, Analyst to the Museum of Paris, from the essential oil of the Eucalyptus, and which he further resolved into two new bodies, *Eucalypton* and *Eucalyptolin;* these substances are, however, of purely chemical interest. The action of the oil—which is easily obtained by distilling the leaves and other parts of the plant—both on healthy and on unhealthy constitutions was carefully studied by Dr. Gimbert. Large doses are poisonous, but smaller ones act as sedatives, and seem to affect the spinal cord, and through it the lungs, circulation and temperature of the body. The presence of an oil similar—at all events as far as regards one of its components, Eucalyptol—to peppermint and the camphor of Java and Borneo, at once explains some of the properties of the Eucalyptus (such as its stimulative and antiseptic action, and its effects on the mucous membrane, circulation, bile, etc.) The tonic and astringent action of the tree is explained by the presence of tannin; but, in order to account for its action in cases of fever, a special substance, supposed to be an alkaloid, was naturally sought for, and M. Carlotti even thinks that he has succeeded in discovering this base in a resinous substance similar to that found in cinchona. In the subsequent researches of Messrs. Borde, Tailotte and other chemists, this product was not discovered, and its existence is, therefore, still doubtful.

Essence of Eucalyptus has already been used for the toilette as an aromatic vinegar. Like all strongly smelling, volatile oils, it is too pungent to be pleasant when pure, but on being diluted the aroma is softened and of a kind quite peculiar to itself, but which, according to some, resembles that of camphor, laurel and peppermint. M. Ramel has had bon-bons made of it, which are recommended in cases of cough and bronchitis.

The *Eucalyptus globulus* is not the only tree of the genus which has volatile oils; all the Myrtle family have organs filled with similar substances, and the popular names of the Eucalypti are derived from their characteristic perfumes. Thus the largest, the *E. amygdalina,* is called *Tasmanian Peppermint* or simply *peppermint.* Experiments are now being made to determine the value of these essences as solvents of resinous substances and even as burning-oils.*

Resins are also common to nearly all the species of Eucalyptus, and the name *gum tree,* or more specially red, white, blue, etc., gum, refers to this product; other popular names, such as *stringy-bark* (*E. obliqua,* L'Heritier, the first described species), *iron-bark,* refer to other characteristics.

But it is time to conclude this sketch originally intended only to have reference to the blue gum of Tasmania, which, in spite of its numerous congeners is the only Eucalyptus that has established a firm footing in those parts of Europe, Asia, Africa, and America, where the climate is compatible with its cultivation. It is, moreover, a rare example of an Australian tree, which has become a citizen of the world by right of its beauty and usefulness.

For ages scarcely able to support a few miserable inhabitants, a wilderness destitute of fruit trees and with but a scanty Fauna, Australia has, in less than a century, become peopled with the cereals, fruits and domestic animals of Europe. Already she sends us, besides gold and richly-flowering plants, wool and the flesh of sheep and oxen, the produce of her immense pastures. Already her flora gives promise of transforming the character of the vegetation of Algeria and the region of the orange; while above

* See in regard to this subject Baron v. Müller's *Indigenous vegetable substances* at the *Victorian Exhibition,* Melbourne, 1862.

the legions of strange types, there towers the commanding form of the Eucalyptus, king of the brilliant cortége.*

* The following extract, taken from the *Popular Science Review* of the 1st April 1875, is interesting:—

"*Tincture of Eucalyptus globulus in Intermittent Fever.*—The following results are summed up, by Dr. Hirsch (*Berliner Klin, Wochenschrift, No.* 30) as obtained from his experiments with the tincture in nine cases of obstinate intermittent fever: (1.) In all cases, after the use of the remedy for one or more days, the spleen diminished in size. (2.) In six cases, three, at most four, tea-spoonfuls of the medicine were sufficient to prevent a return of the paroxysms. In one case only was the double quantity required. (3.) Seven of the nine cases were cured completely; in the remaining two the remedy proved unsuccessful. From these results Dr. H. draws the conclusion, that tinct. Eucalypt. glob. is a remedy but little, if any, inferior to quinine in the treatment of intermittent fever, and that it will probably prove to be as valuable an antiphlogistic in the treatment of other fevers as quinine, digitalis, and veratrum."—J. L. L.

Note on Caoutchouc obtained from the Chabannesia esculenta.

BY G. W. STRETTELL.

Reviewed by Sw.

THE sphere of work of the Indian forest officer is far more extensive than that of his colleague in any part of Europe. Here he is chiefly employed in providing the people and the state with timber and fuel, whereas minor forest produce is of minor importance, except in rare cases. But in India, what is a forest officer not expected to do and pay attention to? In fact so much so, that very often he has no time for his most legitimate work, what with India-rubber, silk, lac, baobab and bamboo plantations for paper manufacture, vanilla and others. Indeed it may almost be considered a misfortune, that the Indian forests are so rich in valuable minor produce, and so well adapted for the rearing of useful plants, which will not thrive in Europe, because there is great danger of the reproduction of timber and firewood suffering by the tempting receipts from articles like India-rubber and others. This is of special importance, as the Indian forests have already been reduced far below the extent required for the welfare of the people. If a sufficient staff and money were granted, there would be little or no harm in the matter, but as the case stands, the budget allowance is small, and the staff far from sufficient to take care of the forests and to manage them according to sound principles. Hence we feel almost sorry, when some new useful plant has been discovered or some additional experiment has to be made, because every fresh discovery or experiment threatens to rob the more legitimate work of a portion of the funds and of the staff.

Unfortunately new discoveries in this line are usually taken up most enthusiastically by those who make them, and it is very difficult for the authorities to decide how much of the information supplied is reliable and based on actual facts, and how much should be put down to exaggerated expectations. Consequently the usual way of escape from such a dilemma is, "to order experiments to be made on a small scale." Now, these experiments look usually very small on paper, but in reality each of them requires, as a rule, as much attention on the part of the staff of officers, as the management of a teak or sal reserve of a hundred square miles, capable of furnishing all the timber required for thousands of square miles of country around it, and it is not to be wondered at, that we look with great suspicion at every new discovery, which can possibly be brought into connection with the Forest Department. On the other hand, however, we should be very sorry to be misunderstood. Unless investigations are instituted and discoveries are made, we should come to a standstill, which means the beginning of retrogression. No, we are decidedly for progress, but what we should like to impress on those in power is—not to neglect new discoveries—but to be careful that their working up does not interfere with the work already in hand, with other words, that we do not spend the working power of the Forest Department staff in experiments, instead of in the management of the woodlands with the view of averting climatic calamities and of supplying the people of the country and State Departments with timber and fuel. Instead of burdening, therefore, the Forest Department with experiments of the class indicated above, would it not be far cheaper and lead to more satisfactory results, if they were made over to the Superintendents of Botanical Gardens, who are always on the spot, and who could carry them out with much less expense of time, than forest officers, whose duty necessitates their travelling over large tracts of country, putting the constant watching of experiments out of the question.

These rather lengthy remarks have been caused by our reading a little pamphlet on a new India-rubber yielding creeper called *Chavannesia esculenta*, by Mr. G. W. Strettell of the Burma

Forest Department. Considerable attention has been paid of late years to the propagation of the Indian-rubber yielding tree, *Ficus elastica*, which occurs naturally in the forests of Northern and Eastern Bengal, in Assam, and the adjoining parts of Independent Burma. Men of scientific attainments and standing have lost their head over the desire to propagate this species all over the country, and have predicted fabulous financial results up to Rs. 240 per acre annually, which resulted in experiments being ordered immediately. To eradicate such ideas, if once taken up, causes much labor and time to men, who look more calmly at the matter, and who base their calculations on actual and not fictitious facts. Hence we confess we look with some suspicion on similar statements.

The *C. esculenta*, it appears, grows in most parts of British Burma, and it is said to be one of those creepers, for the extermination of which in teak tracts an annual budget provision is made. Some of these creepers, growing near Rangoon and Thamine, were found to possess a maximum girth of 11 inches at the thickest part of the stem, whereas the crown covered an area of 300 square feet, at a supposed age of 5 years. The creeper can be propagated either from seed or cuttings. The rubber, which it yields, has been subjected to some preliminary tests, which *seem* to indicate that its quality is similar to that of *Ficus elastica.* In the last paragraph of the pamphlet Mr. Strettell states, that Mr. Galbraith of Rangoon informed him, "that his chemical tests prove the rubber of *C. esculenta* to be purer and better suited to their purposes, than that obtained from the *F. elastica.*" But as it is neither stated what those tests were, or what *their* purposes are, the statement must be taken for what it is worth.

So far so good. But then Mr. Strettell proceeds to say :—

"The foregoing data, then I think, are sufficiently encouraging to warrant the cultivation of this creeper being introduced as a branch of forest administration on an extensive and systematic plan," and he forthwith proceeds to enumerate the following results: "Supposing that 400 acres are planted at 30 feet apart, or 48 creepers per acre, there would be 19,200 creepers in all." He next ESTIMATES the minimum yield of caoutchouc

at 1 viss ($3\frac{1}{2}$ pounds) per creeper per annum, or 19,200 viss in all. The price actually offered for the rubber by a Rangoon house is given at Rs. 2 per viss, hence the total annual yield is Rs. 38,400, or Rs. 96 per acre. The expenditure, it is said, will be "trifling in the extreme;" with other words, it is estimated at Rs. 4 per acre per annum for seven years, after which tapping for rubber is to begin, or Rs. 11,200 at the end of seven years. At the expiration of seven years the expenses will embrace tapping, pressing and preparing the caoutchouc, and bringing it into the market, which are estimated at $12\frac{1}{2}$ per cent. of the gross revenue. Thus with an outlay of Rs. 11,200 distributed over seven years, Mr. Strettell expects a nett return of Rs. 33,600 per annum. This is certainly a most splendid enterprise, and if we believed so firmly in the *C. esculenta,* as Mr. Strettell seems to do, we should not hesitate for a single moment, to give up our present occupation, to proceed to Burma, obtain a large grant of jungle land, and plant *C. esculenta* for a limited number of years, with the view of returning to the land of our forefathers as millionaires.

Unfortunately we are not quite so sanguine, and prefer to consider here calmly, in what respect Mr. Strettell's calculation may possibly be open to objection. In the first instance we consider that the expenditure has been under-estimated. Rs. 4 per acre per annum is far too low, and Rs. 40 will probably be found nearer the mark during the first few years, and even afterwards Rs. 4 per acre will not be sufficient to cover all the expenditure to be incurred in tending the plantation. Then again $12\frac{1}{2}$ per cent. of the gross revenue will never cover the expenditure of collecting the caoutchouc and bringing it into the market. In the Darjeeling District, where labor is half as expensive as in Burma, the expenditure amounts, we understand, to about 25 per cent., consequently it is not likely to be less than 30 per cent in Burma, at the very least.

Thirdly, there can be no doubt that the returns have been over-estimated. A creeper may be fit for tapping at the age of 7 years, but Mr. Strettell does not inform us how he has ascertained that each creeper will yield 1 viss ($3\frac{1}{2}$ pounds) of caoutchouc annually. A full grown *Ficus elastica* tree, cover-

ing not less than $\frac{1}{4}$ of an acre, or 10,890 square feet, with perhaps 30 to 40 large stems and air roots, will yield not more than 5 seers = 10 pounds per annum, if tapped regularly, and it is hardly likely that a creeper of about 12 inches maximum girth covering an area of 300 square feet will yield $3\frac{1}{2}$ pounds per annum. Of course we do not mean to say that the creeper may not yield such a quantity in *one* year, but the *average* yield per annum will, we feel sure, be only a fraction of 1 viss.

Before concluding we consider it our duty to state here as our opinion, that Mr. Strettell, in bringing to notice a new caoutchouc yielding plant, which, according to the data at disposal, promises to be of importance, has added a valuable contribution towards our knowledge of the resources of Indian Forests, but we would offer him our friendly advice, to abstain on future occasions from over-sanguine expectations and calculations, matters which have already done too much damage to Forest management in India, as to be past over silently.

Sw.

On the Killing of trees.

Reply to note by W. J. S., in July number of the "INDIAN FORESTER."

In the year 1870 the theory was satisfactorily established that the current of sap in trees and plants takes place in one—the upward—direction only; and that the distribution downwards of the organized nutritive substances depends altogether upon—the agency of diffusion. The principal channel of sap is the albur-

num, by which conveyance also the hydro-carbons are diffused. The diffusion of organized nitrogenous matter is carried on in the scalariform vessels of the liber. If a girdle be cut round a tree which possesses a dead core—or heartwood—the upper portion is deprived of its water-supply, and speedily withers. In the case of trees which have no heartwood, the girdle only modifies vitality in proportion to its depth; short of complete severance the current of sap cannot be broken. Such a tree accordingly continues to live, and if left to itself soon effects a fresh communication between the separated edges of the bark. But if the healing be obstructed, the tree will die by an inverse process, *viz.*, atrophy of the roots, the formation of new cells in which, and storing of the latter with the needful quantity of colloidal substance, depends upon their supply of protoplasmatic (or nitrogenous) compounds. The object of delaying the application of clay to the girdle would seem to be that of introducing a hindrance to the re-uniting of the gap, just at the time when the effort is about to be made.

M. H. F.

Insect Dangerous to Toon.

CAN any of the readers of the "FORESTER" give me some information about the insect which, almost yearly, attacks the young shoots of the Toon tree boring its way along the pith which it seems to live upon, and leaving behind it an unsightly looking mass of a transparent gummy exudation. The larva is white with black and yellow spots, but I have not yet succeeded in finding the perfect insect. It attacks trees both in plantations and in the forests, and prefers these about 3 feet in height and of strong growth. It seems to attack, however, more particularly those trees which grow in cleared land or near roads, while others growing close by in grass or with other trees, have been comparatively unharmed. Any information about its name and habits, as well as the means of preventing its ravages, will be very acceptable.

J. S. G.

Manufacture of Vanilline from the Sap of Conifers.

THOSE interested in the cultivation of 'Vanilla,' about which so much has lately been talked and written in this country, must read with dismay the note at page 321 of the 'Revue des Eaux et Forêts' for October 1874, and page 180 of that for June 1875, which states that the principle of Vanilla 'Vanilline' can be manufactured from the sap of the Scotch fir, silver fir and spruce, and probably from that of all the conifer family. It is not exactly the regular sap of the tree which is used, but the semi-fluid sap which lines the bark at the moment of the latter being detached from the tree. This being the case, what more easy than to collect it at the time of felling and logging the trees in the yearly cutting. The only preparation which the liquid collected has to undergo, is that of being at once boiled for some minutes to prevent fermentation. It is then packed up in barrels and sent to the factories to be used in the preparation of 'Vanilline.' Messrs. Tiemann and Hermann are making experiments with the view of ascertaining the cost of the preparation of Vanilline in this manner, and its value compared with that from the Vanilla plant.

J. S. G.

Cost of cutting and transport of firewood in the Hills.

CAN any of the readers of the "INDIAN FORESTER," who are engaged in the supply of firewood to any of the hill stations of the N.W.P., or Panjâb, give, through the medium of your valuable paper, some information on the cheapest system of cutting, transport, etc., supposing the cutting in the forest to be at an average distance of 2 miles from the depôt; with the average revenue and expenditure on every 100 maunds brought to depôt. The yearly cutting block should be considered as nearly on a level with the depôt, though sometimes above, sometimes below.

J. S. G.

On Reclothing the Lower Hills.

THESE few lines on reclothing the lower hills may or may not be found worthy of insertion in the "INDIAN FORESTER;" such as they are I send them to you.

To retree, "as the Americans say," the lower hills of the Himalayan range, not to mention the numerous desolate and dreary wastes, lying in various parts of India, I take to be one of the first and most urgent duties of the Forest Department.

Up to date, notwithstanding the exertions that have been made, I believe no success has been met with. I have therefore now to bring to your notice a tree, which I think would succeed and be admirably adapted for the purpose required, if the seeds can only be obtained; the tree I allude to is a native of South America.

When I was travelling in the Argentine Republic Confederated States some years ago, the tree was frequently mentioned to me, together with its uses, never thinking at the time that I should ever become a forester. I did not pay so much attention to the description, &c., of the tree, as I might have done, but the notes I have of it I herewith describe; if it should prove on trial as successful, and as I am sure it will be found, I shall be perfectly satisfied with the result of this my contribution to the "INDIAN FORESTER."

The tree is called the Algarrobo; its botanical name, I believe, is *Hymenœa*, is indigenous to Spanish South America. It grows to a height of from 30 to 40 feet, has wide spreading branches and slender stem, flourishes best on a dry soil.

In and about the province of Catamorea, where it is most abundant, both the population and cattle depend greatly for support on its leaf and fruit.

The long pods are collected annually and carefully stored for winter use.

When required for use the pods are pounded in a wooden mortar, the meal made into cakes, which being dried are fit for use.

These cakes, if I recollect rightly, are called Patay; are largely exported to other districts, in some of which it is the only food the natives have to depend on during the winter.

The portion of the pods remaining in the mortar after the meal has been extracted, is used with the leaves for feeding cattle, which fatten excessively on it.

It is unnecessary here to dilate upon the inestimable boon, the acclimatization of such a tree would prove to this country, providing, as it does, food for both man and beast.

C. B.

Conversion of Abies Smithiana and Webbiana forests into Deodar forests.

By A Green One.

I KNOW but little of the plains, therefore the hills between the Jumna and Giri Rivers, shall be the country that is principally used in this paper.

On many slopes of the Himalayas large dense forests of firs (*Abies Smithiana* and *Webbiana*) are seen, in numerous instances, situated in places where deodar would be most valuable, though the firs are useless.

Most of these forests of firs are on splendid soil, for the strong young firs seem to have ousted the deodars on to rocky and precipitous or exposed parts.

I wish to suggest that these forests can, at small expense, be converted into deodar forest, mixed slightly with evergreen oaks and decidous trees.

The manner I suggest setting about it is, to cut broad slanting lines across the hill sides cutting out all the firs, but leaving oaks and other kinds of trees sparingly.

Lines must never be cut straight up and down because of wash and snow. The lines would have to be cut in a different bearing on nearly every hill side, so as not to allow too much or too little sun to get at the ground.

Width of lines would also vary with height of standing crop, angle of slope, nature of soil, elevation, aspect, dampness, &c.

The felled firs might, in some cases, be profitably used up as charcoal or fuel for lime burning, but in most cases it would be left to rot.

If the fellings are to be used, it would be better to begin in the top line, as the wood most likely would be rolled down to export roads or lime kilns.

Having the forest lined off by blazed trees on narrow paths, begin felling at the top, and sow as soon after the felling as possible, so that the seeds may germinate at once.

When the first sowings are up to two feet make your lines broader, and by increasing them 10 feet in width each year, or if seed is scarce, wait until a plentiful year comes, and then increase all at once.

On the Rearing of groves of Nim trees in Oudh.

EXTRACT FROM THE OUDH GOVERNMENT GAZETTE, DATED 26TH JUNE 1875.

From Captain C. S. Noble, Assistant Commissioner, Unao, late Officiating City Magistrate, Lucknow, to the Personal Assistant to the Chief Commissioner, Oudh, dated Unao, the 6th May 1875.

IN accordance with your No. 3380, dated 2nd August 1871, Revenue Department, addressed to me personally, I forward a report on the experiment of rearing groves of "ním" trees without artificial irrigation, in the method described in Secretary Chief Commissioner, Central Provinces, Circular 47, of 18th July 1871.

2. The spot selected for the plantation was in the Residency grounds—the highest and driest site to be found in Lucknow. The "ním" and "arhur" seed were sown in the month of July 1872, after the ground had been twice ploughed up. This was under my personal superintendence.

3. In December 1872, I was removed to another appointment, but on leaving Lucknow gave careful instructions to the Residency málí to abstain from giving the trees any water, and to confine his interference with the seedlings entirely to keeping them free of weeds. These instructions, from enquiry on the spot, I find were attended to, and, at all events, not a drop of artificial irrigation was given to the plants. Captain Newbery,

in his No. 1803, dated 1st instant, has forwarded to you copies of short notes of the progress of the seedlings, but as Sir George Couper had in his Secretary's letter, referred to in the commencement of this letter, asked me to give my personal attention to and report on the experiment, I now do so, sending this through Captain Newbery's office.

4. I inspected the plantation at the end of last month, and am glad to report the experiment has proved a success. The ním trees, though they were sown only two years and nine months ago, are now looking very healthy and hardy. The growth has been a great deal more rapid than I had been led to anticipate after reading the remarks of Mr. Craw, addressed to Officiating Inspector General of Forests, and forwarded with the circular of Chief Commissioner, Central Provinces, already alluded to. Many of the seedling trees are now 7 and 8 feet high, a growth quite as rapid as, if not more so than, that of similar trees transplanted from nurseries to road avenues, and there carefully tended and watered. What I am most struck with is the straight, even growth of the trees. I always found that in trees transplanted to road avenues, there was a troublesome tendency to excessive lateral growth, by which growth in height was much retarded. In this plantation the trees, being close together, have grown upwards with straight stems, and thrown out but few side boughs. One great advantage in this method of growing trees is that the roots, not being artificially supplied with water, grow downwards a great depth in search of that element, thus giving them a greater hold on the ground when assailed by high winds in the rainy season. This deep growth furthermore, as Mr. Craw says in the correspondence forwarded by the Central Provinces' Government, makes these trees "better able to withstand occasional drought than seedlings whose roots have been kept near the surface by artificial waterings."

5. The experiment now reported upon has conclusively proved that however dry the site chosen, provided it be unassailable by floods and cattle, "ním" trees can be grown successfully in the manner described by Colonel Keatinge. Moreover, I think it would be a cheap and good system to follow wherever groves are required for camping grounds (paraos) on district

roads. A grove might be arranged for in the following manner:—

I.—After selecting a site unlikely to be flooded during the rainy season, enclose the area intended for the grove by a bank of earth thrown out of a ditch $3\frac{1}{2}$ feet deep by 5 feet wide. No path way should break the continuation of the enclosing ditch.

II.—Top of bank to be sown with babúl seed in four rows, one foot apart, all round the enclosure.

III.—Plough up the enclosed land two or three times, then sow the ním and arhur seed in the manner described by Colonel Keatinge.

IV.—Inside enclosing bank, and on all the four sides of enclosure, plant a single line of alternate bargat, pipal, gular, and sisham trees. These are rapid-growing trees, and favorites with the natives.

V.—Entertain a málí for 18 months from date of sowing until babúl has grown strong and thick enough to keep out cattle. Say the sowing would take place early in July, the málí need not be entertained until middle of following October, and his services dispensed with eighteen months after date of his entertainment.

His duties would be to—

(*i*).—Keep the weeds clear of the seedlings.

(*ii*).—Re-sow arhur seed the second season when the old arhur plants are worn out.

(*iii*).—To water the burgat, sisham, pipal, and gular plants only.

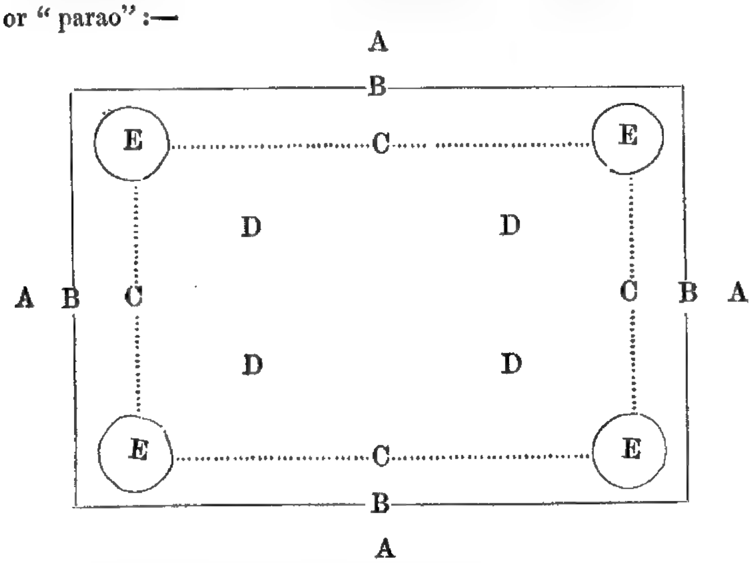
VI.—The babúl fence should be thinned the third year, thinned again the 4th and 5th years, and entirely cut away and removed the 6th year if the ním trees are sufficiently grown to be unhurt by cattle trespass.

VII.—The ním trees should not be thinned nor pruned until the third year, when two out of every three might be cut down. Thinned and pruned the 4th and 5th years, and finally thinned the 6th year. It is hoped the grove would be fit for public use by spring of the 7th year.

VIII.—A good clump of bamboo trees might be planted inside the enclosure, at each of the four corners.

IX.—The sale of babúl wood and young "ním" poles would go towards cost or building a good pucka well in the enclosure in the seventh year, when the grove is thrown open to the public.

6. Below is a sketch of the proposed arrangement for an enclosed plantation, to be subsequently used as a camping ground or "parao":—



A—Ditch outside the enclosing bank.
B—The bank sown with 4 rows of babúl.
C—The line of sisham, burgat, pipal, and gular trees.
D—Centre space to be ploughed and sown with ním and arhur.
E—The clump of bamboos.

From the Officiating Deputy Conservator of Forests, Bahraich Division, to the Conservator of Forests, Oudh, No. $\frac{77}{33}$, *dated* 26*th May* 1875.

SUBJECT.

Ním plantation without artificial watering.

I HAVE the honor, in answer to your No. 15, of 3rd May 1875, to report that in June 1872, one acre of ním was sown with arhur seed in alternate rows as ordered in your letter No. 626C.

of 21st November 1871. The result has been very successful. The young seedlings are now from 1 foot to 12 feet in height, after barely three years' growth. The plantation has not been artificially watered.

I have the following memoranda to record: most of the arhur died, chiefly from frost, in December 1872, but saved the ním seedlings, then three or four inches high. In 1873 rains the arhur somewhat recovered, but died outright in the latter part of 1873.

The ním suffered very much from frost in January 1873, recovering in the rains of 1874. In December 1874 the ním suffered again from frost, and numbers of the small seedlings died. On the 17th of the current month, I examined and measured the ním seedlings; there are about 600 young saplings, which have thrown out new shoots from where they were frost-bitten.

From the above you will perceive,—1*st*, that arhur will not last more than 18 months at Motipur; and that, 2*ndly*, ním suffers severely from frost.

I cannot at this moment account for the marked difference in growth, namely a large number of seedlings, now only 1 foot high, and some as high as 12 feet, a great number from 5 to 10 feet high. Another thing I noticed was that to the south of the existing indigenous old sal and ebony trees that were not felled in this acre of ním, the ním is more hardy and prolific and thick.

To me, as an observer on the spot, it appeared that ním should be sheltered from the north winds.

Treatment of Ornamental Trees.

Extract from the Gardener's Chronicle.

IT may be worth while to state the great success I have had in a mode of treatment of large, old and ornamental trees on a lawn and area of ground adjacent to a residence, where it is a great object to preserve such trees in a state of vigour to guard against the commencement of decay. It is desirable to state in the outset that where leaves are annually removed in order to keep a place in nice condition, trees are deprived of their natural nourishment, but even when not removed they are blown about so as to render them of little or no avail in affording food and nourishment to the roots of the trees. It is also clear that these trees have been grown for 100 to 150, or a greater number of years, and where the soil is not perhaps very good it must necessarily be exhausted and impoverished. Therefore after a long period has elapsed, it is not to be wondered at—on the

contrary it is to be expected—that time will tell on the trees, and that they should show symptoms of standing still in their growth—of a stationary condition at least in the first instance, and subsequently of the commencement and advance of decay. These considerations attracted my attention years ago, and created a desire to arrest such downhill progress, and devise a remedy, at the same time to steer clear of any experiments which might prove injurious. One of the symptoms I observed, especially on lime trees, was an increasing smallness of the leaf and a shortness of the annual shoots. I set to work some fifteen or eighteen years ago to give some safe treatment to the trees. Without stirring the existing surface, I began to lay on around the stems of the trees, and at least as far round as a circle with a circumference rather beyond the extremities of the branches, a coating of good earth with which some lime had been mixed. The compost, which was laid on about 5 inches thick when loose, gradually became solid, and remained about 3 inches thick. There was no difficulty in giving this amount of compost to a small number of trees; but it was obvious that earth could not be found within a moderate distance to apply the same treatment to a large number, and that the cartage, even if it could be found, would be a large expense if twenty or thirty cartloads were to be applied to a large number of trees. But as regards the trees to which this treatment was applied, the result was most satisfactory. The earth being laid on in the winter and spring no effect was visible in the first summer; but in the second summer the leaves were double their former size, with quite a new vigour; in the third year the leaves, which had before been little bigger than half-a-crown, were four times that size, and some of them almost as large as dessert plates, on thick and succulent shoots. To a certain extent similar results were attained, but on no tree was the difference so great as on the lime tree, as all the fine fibres of the roots pushed up into the new soil and nutriment. But I was desirous to see how a similar result might be attained by a less expensive and laborious process, so that the effect might be kept up and extended to a greater number of trees. I bethought myself of a very simple and cheap process, which

I have now practised for a succession of years with most satisfactory results. The leaves of the whole of the trees must be cleared at all events, in order to keep the place in nice order, and the practice I have followed is to rake all the leaves off a certain area round the stumps of about one-third of the whole number of trees within a certain space, and to place a coating of leaves about 7 inches thick in a circle from them to a circumference as far as the branches extend. This will gradually sink down to a coating of 3 inches of solid and decaying leaves; and thus there is created a coating of decaying leaves or leaf-*mould—the most appropriate food of trees. Into this coating* the root fibres push and are sure to find their best nutriment, the youth of the tree is renewed, and a new lease of life seems to be given to it, with all the vigour of youth and the strength and magnitude of manhood. If a little earth or vegetable rubbish can be laid over the leaves it secures their not being scattered by the wind, and a few branches of trees will assist in this object—these can be removed when the leaves are somewhat consolidated. I can state with truth that on a mass of large trees, which I have had thus treated, I see an increase in the size of the trees and quite a new vigour in their growth. It is my intention to repeat the treatment once in three years, to keep the gentle action of the nourishment of the trees in the wood and outlying trees to which I mean to apply it. I consider that the leaves will afford the means and necessary supply once in three years to the whole of the trees. Much more might be said, but already this statement is too long, and persons who may take an interest in the subject will readily think for themselves, and see how simple a matter it is to confer a benefit on favourite trees. *T. F. P.*

Fleischmann's Hypsometer.

Mr. Ribbentrop, in the Report of the Forest Conference in the Punjab in 1872, describes Fleischmann's Hypsometer, but he does so in such brief terms as to render us unable to make one here in our workshops. Perhaps Mr. Ribbentrop could find time to publish a somewhat more detailed description and sketch of it. G. F.

Arboriculture in its relation to Climate.

Much has been written of late on this subject, and with special reference to *Eucalyptus Globulus*. Still the subject does not seem to have been exhausted, and the following papers will doubtlessly be found interesting.—THE EDITOR.

From Her Majesty's Secretary of State for India, to the Government of India.

I forward herewith, for the consideration of your Lordship in Council, copy of a memo. by Lord Mark Kerr on the Delhi Sore, and request that I may be informed whether the attention of the Sanitary Officers of your Excellency's Government has been attracted to the statement regarding the alleviation of the disease by planting trees and grass, and whether any report has been received on the subject.

Memo. by Lord Mark Kerr, on the Delhi Store, republished from the "Indian Medical Gazette."

"Before my arrival in India, I had heard of the existence of "certain boils and sores in many Eastern Cities which having "*once* been places with enormous population and all the "acquirements of wealth and luxury, well drained, well watered "and adorned with numerous trees and gardens, had, in the "process of centuries, become, for the most part, desert wastes, "their canals and water-courses choked up, and their only "vegetation unwholesome weeds. I knew such to be the case at "Bagdad, Alleppo, and other places. When I arrived at Delhi, "I found the inhabitants, and those with whom I, as Brigadier-"General, was most concerned, the garrison both European and "Native, to a great extent suffering from boils, sores and un-"sightly fungus-looking growths on their hands and limbs; "and I found Delhi within the walls a surface of barrenness, "covered here and there for the space of two miles in length "and 500 yards in breadth, by foul weeds or heaps of demolished "buildings, with wells and water-ducts choked up. I informed "the Viceroy and the Commander-in-Chief of the state of

"things, and of my intention to plant trees and grass so as to "remove the cause of evil. I had previously obtained the Lieute-"nant-Governor's sanction, and funds sufficient for the purpose.

"One circumstance confirmed me as to my opinion of the "cause of evil, and induced me to make a trial, which still "further strengthened this opinion. The men of the Cavalry "Regiment stationed near the Cabool gate amongst trees and "grass were entirely free from boils and sores, and I sent out "those of the rest of the garrison of the 82nd Regiment and "the 12th Native Infantry, unfit for duty from the sore, under "canvas amongst the trees and verdure of the old Cantonment, "with the most satisfactory results, the worst sores becoming, "after the first week, greatly ameliorated, and the slighter "cases returning to duty day by day at the same time.

"I continued planting as the ground became cleared, and I "restored an aqueduct which still takes water to gardens in "Durriangunge from the further side of the Chandnee Choke.

"I left India in January 1864. I informed His Royal High-"ness the Duke of Cambridge on my arrival in London of "what I had done, and of my sanguine hopes of success. Since "then I have from time to time heard such satisfactory "accounts of the growth of the trees and gardens in Delhi, and "the gradual diminution of the cases of sore, that I resolved, "on hearing that the Commander-in-Chief was to hold a Camp "of Exercise at Delhi to come out and see for myself.

"I am most truly rejoiced to find the disorder has, at the "end of these years, almost disappeared from Delhi. I am "aware that other reasons are now urged to account for the cure "of the sore, but not even the plea of the stamping out of the "contagion can account for the non-appearance of fresh cases "amongst either the Native or European population.

"Without wishing to claim credit for myself in the matter, "I am very anxious that the experience of this City of Delhi "should be made known for the benefit of other regions in "India where the like pure irrigation and draining with judi-"cious planting and gardening would, I firmly believe, remove "not only sores and such like evils, but prevent the approach "of more serious and even fatal scourges."

From Surgeon-Major E. Morton, H. M.'s 29th or 2nd Belooch Regiment, to the Deputy Surgeon-General, S. D., Kurrachee.

SIR,

IN obedience to your memo. No. 1018 of 1873, to which my attention has recently been called, directing Medical Officers in charge of Native Troops to conduct a careful enquiry into the nature and causes of Sind Sore, I have the honor to remark, that I have had no opportunity of instituting a specific investigation into the pathology of the disease. I am therefore unable to offer any opinion regarding the nature and causes of Sind Sore, whether it be local or constitutional, parasitic or otherwise; nor am I in a position to trace any inter-relationship between the form of ulcer known as "Sind Sore" and the so-called "Delhi Boil."

2. The object of the proposed enquiry being two-fold, 1*st*, *to obtain a more accurate knowledge of the character, to* elucidate the origin, to direct the treatment, and to accomplish the prevention of Delhi Boils and Sind Sores; and, 2*nd*, to test the accuracy of Lord Mark Kerr's conclusions, so forcibly expressed in his memo. to the effect that by the judicious planting of trees and grass, the opening of old canals, water-courses, &c., or in other words careful attention to general sanitation, the disease called Delhi Boil may not only be mitigated, but altogether eradicated. The remarks of Lord Mark Kerr on this point having a special and specific bearing, I cannot avoid the conclusion that his Lordship has attempted to prove too much. The measures which he took to mitigate the evil of the Delhi Boil were of general, rather than special sanitary arrangement; in fact I may say a system of sanitary procedure based on common sense and common experience, attention to which will undoubtedly greatly influence the development, the prevalence, and the persistence of any disease. For I need scarcely remark that in proportion as the body is weakened and the vital powers lowered by surrounding insanitary conditions, it yields the more readily to the pernicious influence of morbific agencies from whatever source proceeding.

3. Viewing the subject in a general sense and in the light of the belief expressed in the latter portion of the memorandum,

that "the like pure irrigation and draining with judicious planting and gardening would, I firmly believe, remove not only sores and such like evils, but prevent the approach of more serious and even fatal scourges," Lord Mark Kerr's words have a wide significance and a most important bearing, especially in connection with paludal malarious fevers, the most prevalent, and in their ulterior consequences the most fatal diseases of India.

4. The practical connection of agriculture with health and strength, with sickness and mortality, is inseparable from a comprehensive consideration of the public health. It has been operatively exemplified in England where diseases usually attributed to marsh miasm, and which were formerly so destructive to life, numbering James the 1st and Oliver Cromwell as victims, have almost disappeared, owing to land-drainage, town-sewering, and improved methods of agriculture. So with other countries I need not instance, where like salutary and beneficial results to health have flowed from carrying into effect enlightened principles of agriculture and sanitation which go hand in hand.

5. Agriculture, used in its extended sense, including every description of territorial improvement, comprehending irrigation, embanking, road-making, drainage, arboriculture, &c., is every where the most powerful improver of climate. Wedded as the natives of India are to the primitive customs of their forefathers; bound by immemorial usage to their rude but time-honoured system of cultivation, a policy of improvement is alien to a people so conservative, who have practised agriculture and nothing else for ages. Considerations of profit or of health are alike disregarded through popular ignorance, indifference, and the accumulated prejudices of centuries. It therefore follows that agricultural improvement, whether viewed in its life-sustaining or in its life-preserving aspect, devolves as a special duty on the State. The subject is one of vital importance at the present time, when measures to meet the requirements of the people and to avert famine are attracting much public attention. Happily it cannot now be said, as in the case of so many former famines, that "hopeless anguish poured its groan, and languid want retired to die."

6. It will probably be conceded that in all public measures for material advancement, safety to health is the first thing to be sought, and profit must come afterwards. It will further be conceded that irrigation is a matter of life and death to our Indian subjects, whether viewed in a hygienic or in a food-producing light. But how stands the question in India in relation to our great reproductive public works? Do not the most pernicious results flow from looking at irrigation entirely with a view to its main end, and that no part of its efficiency for that end should be sacrificed for promoting any other end, however excellent?

7. The problem of sustaining an ever-multiplying population pressing with an ever-increasing intensity on a soil with stationary powers of production has called forth in this country a policy of internal development which in itself involves dangers that have not been fully recognized. Irrigate the land any how and produce plenty is the policy of the day, but the fact that a large water-supply without the provision of adequate drainage outlets means a high ratio of sickness and mortality seems to be considered of little moment. There is no reason why increased food-production and pestilence should march together, if irrigational works are projected on well-known sanitary principles. There is no reason why the blessing of material prosperity should be attended by the curse of disease. But that the latter follow the former is painfully apparent on too many of our irrigational works, nowhere perhaps so disastrously as in the Godavery Delta. There water flowed in abundance from the great system of works in operation, but it flowed as a plague over the land. There was one fatal defect in the scheme, sanitary laws had no place in it. A wealth of water was poured forth without the provision of sufficient escape-channels for its removal, and the result was pestilential stagnation, which generated an atmosphere of death throughout the district. To stay the pestilence, the Government of Madras have sanctioned a large annual expenditure on "special works of drainage" for, in the words of the Government Resolution on the subject, "remedying this most crying evil, whereby at present the gift of financial prosperity bestowed

on the District is coupled with the curse of disease." Epidemic disease, the expenditure of a lac of rupees annually, and the temporary remission of taxation to the infected villages, are the results of irrigation viewed in the sole light of material advancement. This is not a solitary instance: there are many districts where the same results, though not so marked and fatal, follow in their silent uninterrupted course.

8. The duties of the Government of India being to a certain extent paternal, the obligation is imperative to study the great changes which are taking place adverse to the salubrity, and to the public and private hygiene of irrigated districts. Day by day it becomes more imperative, for population follows in the wake of irrigation, and unless engineering science is directed to the sanitary aspect of the subject in providing the most efficient, the most wholesome, and the most economical drainage escape-channels, the pest of endemic disease, occasionally relieved by fatal epidemics, must always hover over the land. But apart from the hygiene of the subject, a more extended system of drainage is called for as a question of profit, for where irrigation has been long practised the soil becomes water-logged, crops deteriorate, and sterilization ultimately ensues. We might draw many useful lessons from irrigation as practiced in Southern Europe, where Prefects, Syndics, and Tribunals of waters are specially charged with a general supervision of the interests of the community ; where the natural drainage of the country is not allowed to be interfered with by the new irrigation, and where irrigators are bound to drain off the waters which percolate through the lands and swamp grounds at a lower level. There every other consideration must give way to the health, happiness, and well-being of the community. There the perfection of irrigation means the highest standard of production, with the lowest ratio of disease. In Northern Italy rice grounds are ordered to be kept at a distance of 14 kilometres, or 8·7 miles from the large cities to 1 kilometre, or 1,094 yards from the smaller towns. Even in Spain, the most unprogressive country in Europe, where rice cultivation produces much sickness, it is not unfrequently forbidden altogether, or restricted to certain places. It is true

irrigation is not carried out in Southern Europe on the gigantic scale of this country, but the greater the danger to human life from the greater density of population in India, the greater should be our sanitary preventive measures.

9. The cumulative and persistent pernicious action of paludal malaria is too apparent on all sides in the mental and physical degeneration of those constantly exposed to its influence to require observation. But I may ask how many fever-stricken spots are there in the districts where disease revolves in the same calamitous monotony, yet we have made no attempt to strike at the root of the evil,—nay we aggravate it by planning our irrigational works in opposition to the laws of health. We cannot plead ignorance of the subject, for we have long had a right understanding of the causes of paroxysmal malarious fevers, so varying in their nature, so general and complicated in their influence on the system, that almost every organ is implicated, almost every function suffers, for they have essentially the same fatal effects, whether viewed in their tendency to destroy life speedily, or in their remoter organic results.

10. Sanitation has not been allowed to fall behind the science and requirements of the age in our large cities, at least many salutary and beneficial reforms have been effected. But how stands the question in our rural districts? Have we not forgotten that nothing more marks India from Europe than the greater density of the rural, as distinguished from the urban population. I would ask what artificial means of health-amelioration and disease-prevention have been introduced for this vast rural population? What special measures having health as the sole end, aim and object have been organized throughout the land? Measures of the nature of swamp drainage, sub-soil drainage, and arboriculture, which the French have carried out with so great and so marked success in Algeria, in the Department of the Gironde and in the "Landes de Gascogne" (The brambles of Gascony). Is not the spirit and tendency of rural improvement to make artificial swamps, to saturate the sub-soil with moisture and vegetable débris, to produce plenty, and to develop disease? It is computed that

about one-third of all Hindoostan is composed of alluvium, more or less malarious. Looking at this vast area in a hygienic sense, with its teeming population, what a wide field is here presented to modify the severity and to reduce the mortality of disease. We spend large sums annually in Cinchona cultivation, but we are in a great measure heedless of the external causes which produce the diseases for which Cinchona is a remedy. Self-preservation demands that we stop an evil at its source, and though we may have a tolerably certain remedy to stay the deadly effects of malaria, yet the cure is very costly, and often not within the reach of the poor rural sufferer. It is to be feared that the following remarks of an intelligent observer of the famine now unhappily overshadowing a large portion of Bengal are but too true: "In the richest districts of the richest province of the Empire, pestilence has been doing a work during the past ten years with a silent unintermitted unappeasable persistence, far more appalling to those who have watched the facts than the most obtrusive range of famine;" in other words, famine kills its thousands, and pestilence its tens of thousands.

11. In Algeria, the Landes de Gascogne, and the Department of the Gironde, the superior efficiency of measures of prevention over those of cure has guided the French in their extensive scientific experiments, especially in arboriculture. So far back as the year 1695, the protective influence of belts of trees in the vicinity of the Pontine marshes was practically recognized. Indeed, to go farther back, the health-conserving property of trees was known to the ancients. That the peculiar attraction which marsh miasm has for the foliage of umbrageous trees should have been so long known and turned to so little account in this country must be a matter of surprise. For years we have had practical experience of the fact that trees afford a certain protection from, and a remedy against, marsh miasm, that dwellings within the immediate vicinity of marshes may be made, comparatively speaking, healthy by judicious tree planting,—nay we have practical demonstration of it in Demerara and other parts of British Guiana, perhaps the unhealthiest country in the Tropics. Yet what organized plan for carrying

this knowledge into salutary effect has been introduced? We have a highly organized Forest Department established on what basis?—the basis of hygiene, or the basis of profit? or of both combined, for they are very far from incompatible?

12. The result of French scientific arboriculture in Algeria has been embodied in a paper lately read by Mr. Gimbert before the French Academy of Science, conveying his unbounded faith in the marsh miasm-destroying powers of the *Eucalyptus Globulus*, which he attributes partly to the exhalation of camphorous vapours, and partly to its singular water-absorbing powers. The relation of cause to effect which co-exists beween certain conditions of the soil and the development of fevers and maladies of various natures can scarcely be considered matter of conjecture. Given moisture, an impervious subsoil at a depth of a few feet, vegetable and animal contamination, with favouring meteorological states, and all the conditions of disease development are fulfilled. It may therefore be logically inferred that the peculiar water-attracting powers of the *Eucolypti* in absorbing the surrounding impure surface-water and assimilating its animal and vegetable contaminations must be highly salutary. The health-conserving properties of trees yielding gum-resinous exudations as the *Coniferæ* has not escaped the observation of French sanitarians. The pestiferous climate of the "brambles of Gascony" has been completely changed by planting large forests of the *Maritime* pine, combined with surface drainage, and so paludal fever or the "mysterious Pollagre" has entirely disappeared throughout the vast plains of the Landes de Gascogne, so with the Department of the Gironde, and in a few years it is to be hoped the like happy climatic conditions will prevail throughout Algeria.

13. The remarkable fact that swamps in Australia, Tasmania, New Zealand, and New Caledonia do not produce paludal fevers was in itself a subject worthy of careful investigation. But here again French sanitarians in their extensive scientific experiments in Algeria with the *Eucalypti*, or the Giant Gum Trees of Australia and Tasmania, and with allied species of the *Genus Myrtaceæ*, have in a measure solved the problem. Nor has profit in these experiments been overlooked, large quantities

of sticks of a species of *Eucalyptus* have of late years been imported into England from Algeria for walking sticks, and in the Paris Exhibition of 1867 the leaves of the *Eucalyptus Globulus* were made into Cigars and recommended as an aid to digestion. The leaves of another species of *Eucalyptus* have been used on the Continent in place of lint for wounds, and have been found healing as well as antiseptic. But apart from the reputed febrifuge qualities of the *Eucalypti* and the remarkable water-absorbing capacity of the *Genus*, which is said to be so great as to be capable of drying up a pestilential swamp, and converting it into a dry and healthy district, the subject may be viewed in another light, and one which always commends itself to our notice. Looking at it in the light of commercial profit, the timber of the *Genus Myrtaceæ*, of which there are from 100 to 150 species, is most valuable. The Australian Colonists distinguish the *Eucalypti* by peculiarities of bark, some have smooth, other rough bark, some have fibrous (stringy bark), while others are solid (iron bark). The *Eucalyptus Globulous* (Blue Gum) *Eucalyptus Gigantea* (stringy bark,) and the *Eucalyptus Amygdalina* (Peppermint Tree), yield the most valuable timber, hard and durable, while the bark of some varieties which is shed from time to time is useful for firing, owing to the quantity of resinous matter it contains. The Cape Colonies where the *Eucalypti* have been introduced tell the same tale of the hygienic properties of the *Genus*, one species of which, the *Eucalytus Globulus*, is said to have exercised a marked beneficial effect on the climate of unhealthy districts. The *Eucalypti* yield valuable timber, are easily acclimatized, grow rapidly in almost any tropical or sub-tropical region,* possess highly valuable hygienic and medicinal properties—in a word, the *Genus* is alike calculated to improve the health and to add to the wealth of the country. Besides there is another and most important point in connection with the water-absorbing powers of *Eucalypti* on which I have not touched. I refer to the water-saturated soils of the plains of Bengal and elsewhere, the

* Dr. King, who is an authority on the subject, has only lately stated that the *Eucalyptus Globulus* will not thrive in Lower Bengal, and the Government of Bengal have accepted this verdict.—THE EDITOR.

yearly decreasing productive power of which has given rise to the erroneous argument that irrigation sterilizes, not fertilizes. The best system of extended drainage where the ground becomes water-logged and sterile has yet to be devised by engineering science. Might not the judicious planting of the *Eucalypti* solve the problem?

14. It is well known that the Delta of the Ganges is the birthplace and cradle of cholera, that the towns of Hurdwan and Jessore and other places in the Gangetic Delta have originated the disease, which passing westward has swept over Europe as a pestilence, penetrating even to America. Pettenkofer's ground and ground-water theory as regards the origin and spread of cholera is too well known to require remark. It has been violently attacked, and the controversy is still raging. But evidence connecting paroxysmal malarious fevers and other diseases with the soil is conclusive. The soil must play the principal rôle in the development of certain maladies. In any place where there exists at a depth of from 2 to 3 feet an impervious sub-soil contaminated by decomposing vegetable matter, intermittent fevers, &c., are there to be found: where it is contaminated by animal putrefaction, typhoid fever. Why then should Pettenkofer's ground and ground-water theory be so assailed when the genesis of cholera in the Gangetic Delta, its Head Quarters, is doubtless due to the soil and subsoil-water, saturated with vegetable and animal decomposing matter, which under favouring meteorological conditions develop the "cholera germ?" There are no effects without causes, and we must get at the cause if we would prevent the effect. It is our concern to find out how the pest of disease may be most surely, most effectually, most swiftly stamped out. Might we not try a little Munich hygiene, or the preventive principles of the French, and carry out extensive arboricultural experiments with the *Eucalypti* and other health-conserving trees in Hurdwan and Jessore, and other places unfortunately known as hot-beds of he disease, and if possible confer a boon on humanity?

15. Hygiene is a science which has claims to public recognition and to Governmental support on the grounds of the inestimable benefits it has conferred on mankind. Jenner in

his discovery of Vaccination; John Howard in his great Prison work and his final triumph over Jail fever; and Captain Cook in his successful prevention of Scurvy demonstrate how much hygiene has contributed to the happiness and improvement of man's condition, intellectual, physical, and moral. I would earnestly commend the subject to the consideration of the Government of India, in the hope that when the present feverish paroxysm of expenditure attendant on the famine so unhappily hovering over Bengal has subsided, it may not be succeeded by a cold fit of economy, where our common aim "the improvement of man's estate" is at stake.

16. Turning to climatic amelioration and its intimate connection with arboriculture, I fear there is too much truth in the assertion that the climate of some parts of India has of late years been more arid and injurious to both animal and vegetable life, on account of the increased demand for wood diminishing our forests in extent. Spain presents an example of a country where the climate has been seriously injured, and where the people in their infatuated dislike to trees have cut down whole forests—nay, they carry their dislike so far as not to plant any but fruit-bearing trees. We know the value of forest in a profitable sense, and we have only to realize the benefit of arboriculture as a safeguard to health, and an improver of climate, to stimulate activity in this direction. The British Army is in itself a proof of the general unhealthiness of the country. Notwithstanding all that has been done for the health and welfare of the British soldier in this country, we have not been able to change the climate of India. Indeed, I may say, we have never made any organized attempt to change it. It is true that many and various local causes of disease have been removed from every European station throughout the land, but the same physiological actions are in existence as formerly, which render India a dangerous country to the British soldier. As a rule we find that mortality and invaliding represent the opposite scales of a finely adjusted balance. Of late years mortality has considerably decreased, but invaliding has increased in almost exact proportion, and the result is that the total loss to the

Service is very little less than when our soldiers died in India, instead of being sent home invalided.

17. For climatic purposes we have to consider trees whose natural habitat lies in the vicinity of the sea-coast, and thoes suitable to the interior of the country, as also their commercial value. In respect to the former class of trees, the first in importance is the *Pinus Pinaster* (Cluster or Bordeaux Pine) one of the *Genus Coniferæ* which is indigenous to European countries bordering on the Mediterranean, and flourishes close to the sea. It has been found of vast importance in the Landes de Gascogne and the Departments of the Gironde in France, not only in a hygienic, but in an agricultural sense, for by means of large plantations formed of it, great tracts of land adjoining the sea-coast swept by ever-rolling sands have been reclaimed and turned to useful agricultural account. It has completely changed the pestiferous climate of those Departments, and is further valuable for the great quantity of turpentine it contains. For inland plantation we have a field as extensive in its range as the Australian Acclimatization Societies have made it, in laying under contribution, both in the animal and vegetable world almost every known country, not excepting that large and interesting Island Madagascar, about which we have known so little until recently, though it was discovered towards the close of the 13th century by the celebrated Venetian Traveller, Marco Polo. The Queensland Acclimatization Society has obtained and acclimatized the splendid Madagascar tree, *Poinciana Regia, Suborder Cœsalpineœ, Order Leguminosœ.* From the same country may be obtained the majestic *Rofia* palm, the leaflet of which splits into threads, and woven into cloth is used for many purposes. Likewise *Revenala Madagascariensis*, a magnificent palm-like plant constituting a genus of *Musaceœ*, called the ‘ Traveller's Tree," because the leaves, when cut, and the stem, when pierced, yield an abundant and refreshing juice. The seeds are edible, and yield an essential oil. From Sumatra we might succeed in acclimatizing its most interesting and important tree, the *Dryobalanops Camphora* (or Camphor tree) of the Genus *Dipteraceœ* which grows to a height of 100 to 130

feet, and forms a trunk 7 to 8 feet in diameter. It is much prized by the Malays and Chinese, both for its camphor and wood. From British Guiana, that immense garden stored with an infinite variety of vegetable life, we might obtain the Chocolate tree, (*Theobroma Cacao*) the Cabbage tree palms, and many varieties of trees valuable for timber or ornamental furniture, and other purposes.*

18. I shall briefly refer to three vegetable products having useful, and to some extent hygienic properties which do not strictly come under the head of arboriculture. From Australia we might obtain the *Xanthorrhœa* (The Black-Boy or Grass-Gum trees of Australia), a most remarkable species of *Liliæcæ*, an order which affords many beautiful plants to the florist, one or two possessing medicinal virtues. The tall-growing species *Xanthorrhœa Arborea* and *X. Hastilis* form conspicuous features in some Australian landscapes, the leaves affording good fodder for cattle, and the white centre of the top of the stem food for man. In Madagascar a species of nettle yields a tenacious fibre, resembling hemp, which is spun into strong and durable cloth. At Sierra Leone a species of grass (*Bahama* grass), allowed to grow in the streets, is supposed to have improved the health of the place.

19. The question is one absolutely of hygiene, to be decided by scientific demonstration of the course most conducive to public health and prosperity, and I humbly trust that the facts and circumstances herein detailed may not be considered irrelevant; and that the importance of the subject, both morally, socially, and commercially, in which profit, health, and climate are so intimately connected, may commend itself to the favourable consideration of the Government of India. If on some points I have not spoken with "bated breath and whispering humbleness;" if I have drawn parallels to demonstrate our sad shortcomings in the science of hygiene, the end and aim, the motive and object in view, will, I hope, be held to plead my excuse.

* We have no desire to make any remarks on the above recommendations of those trees which are supposed to be *specially* qualified to counteract excessive moisture, but it appears to us, that out of the 2,000 species of trees which are found in Bengal and Assam, for instance, many might be found which would answer the purpose here aimed at as well or even better, than the exotic trees enumerated by Surgeon-Major Morton.—THE EDITOR.

II. Reviews

Forest Flora of North-West and Central India,

Commenced by the late J. Lindsay Stewart, M.D., *Conservator of Forests, Punjab, continued and completed by Dietrich Brandis, Ph. D., Inspector-General of Forests to the Government of India. London: Allen,* 1874.

By George King, M.D.

Among the large number of trees indigenous to India it is wonderful how few are considered by the natives of the country as valuable on account of their timber. This is due to various causes, partly to a lazy wasteful disposition to reject all but the very best, partly to the total absence among the natives of any method for the preservation of cut timber, often to the want of proper tools for conversion, but also very greatly to ignorance of the properties of the various indigenous timbers. A timber-dealer in the plains of the North-West Provinces still classifies all trees in two divisions. To the one he admits only sal, sein, sissoo, and possibly koosum and sandan. To the other he contemptuously relegates all other trees indigenous in the province, and as a rule he is unable to distinguish these from each other by name, either in the forest or in the timber-yard.

When the attention of Government began first to be given to the preservation of the forests of the country the contents of these forests were nearly as little known as their boundaries. The latter are being gradually settled, but a thorough knowledge of the former is more slowly arrived at, involving as it does the education of a special class of officials trained to observe and to appreciate and recognise specific differences among trees as they grow, as well as to guide and direct the utilization of forest produce of all kinds. No true progress could be made in the direction just indicated until the knowledge of the Indian trees, already existing scattered in the works of writers on Indian Botany and in the brains of living students, had been reduced and arranged in a compact consultable manual, and such

a manual naturally suggested itself in a scientific form, in other words, in the form of a *Flora sylvatica* or systematic description of the constituents of the forests of the country. As a matter of convenience, the *Flora sylvatica* of India has been divided into sections. That for the Peninsula prepared by Major Beddome has been for some time before the world. The section for North-West and Central India is now under review; a third for Burmah is in preparation, and others may possibly follow.

A profound knowledge of Botany is not necessary to a forest officer, for Forestry is an art and forms no integral part of botanical science. But like other arts it is, even if empiric in origin and practice, not only capable of being supplied with a scientifi cbasis, but is vastly strengthened by such a basis. The possession of a certain amount of botanical knowledge, and above all of the habits of observation which the practical study of botany engenders, are of the greatest use to the forester. The learned and scholarly book, of which the title stands at the head of this article, puts into the hands of the forester in Upper India a fund of information about the trees and useful plants of his province, to avail himself of which to the fullest extent will require very little botanical training on his part. In fact the careful study of any elementary manual, such as Oliver's First Book of Indian Botany and the dissection of a few flowers and seed vessels, will form a sufficient preliminary equipment.

Originally begun by the late Dr. Lindsay Stewart, this Forest Flora for Upper and Central India was continued and completed, as it now stands, by the present Inspector-General of Forests, Dr. D. Brandis. The work was written in the Herbarium at Kew, where unquestionably exist the best materials for any work on Indian systematic Botany. Dr. Stewart was an indefatigable note-taker and, during his innumerable tours in Upper India, he amassed a large amount of information on the local uses of plants of every kind, herbaceous and woody. He also collected with painful diligence an immense number of vernacular names. Part of this information was published six years ago in Dr. Stewart's book on Panjab plants, which volume, as well as his unpublished notes, have been largely utilised in the present work. Dr. Brandis has himself tra-

velled extensively over the same ground as Dr. Stewart, and although the preparation of a *Fora sylvatica* formed no part of his plan during these journeys, he made an extensive series of notes which have also been taken advantage of. Neither he nor Dr. Stewart having however sufficiently explored the forests of Oudh and Central India, a special officer, (Mr. Richard Thompson) was deputed to collect in these provinces. This book has therefore had every advantage in the way of material and of field notes, and it must be said these materials have been most excellently used.

The natural and political divisions of a country do not, unfortunately as a rule, coincide. The scientific forester regards the former as of more value and significance than the latter, and these Dr. Brandis inclines to follow as far as possible in limiting the area dealt with in his flora. He therefore includes the arid tract occupied by the independent native states of Rajpootana, which lies between the Panjab, North-West and Central Provinces, and of which the flora has from its scantiness and desert type a peculiar interest. Northwards his limit is the treeless region of the inner Himalaya from the southern bend of the Indus to the river Kosi; southwards it is the Maikal and Satpura range of hills; the western limit is the Panjab Frontier along the foot of the Suliman range and the river Indus in Sindh; and eastward the territory is "bounded by a broken line which follows the Nepal Frontier, first along the Sarda and Kali rivers and afterwards parallel with the foot of the Himalaya until it touches the great Gundak river, and from that point by a straight line drawn in a S. S. Westerly direction through Benares and Amerkantak and Bilaspur." The area thus demarcated includes a variety of climatic conditions which are thus described by Dr. Brandis :—

"*First.*—The entire arid regions of India with scanty vegetation and uncertain rainfall, and an atmosphere dry nearly throughout the year (South Punjab, Sindh and the States of Bhawalpur, Kairpur, Bikanir, Jessalmir, and the greater part of Marwar).

"*Second.*—The entire northern dry zone, surrounding the dry region on the north and east, forming a belt from 100 to 200

miles wide, with a normal annual rainfall between 15 and 30 inches, which includes the plains of North and North-West Panjab, outside the sub-Himalayan tract, Delhi, Ajmir, Gwalior and of the Rajputana States, Bhurtpur, Jeypur and Meywar.

Third.—The western end of the north-eastern moist zone, with a heavy monsoon, and an annual rainfall exceeding 60 inches, which comprises the Burmah Coast, Bengal, the sub-Himalayan tract, and the outer ranges. That portion of this moist zone, which extends into the territory of this Flora, is a narrow belt, probably nowhere more than 30 miles wide, narrowing gradually towards the north-west and terminating at the Ravi. It includes part of the Gora kpur and the Northern Oudh forests, the Siwalik tract, the Doons and the outer ranges of the North-West tHimalay.

Fourth.—A portion of the large intermediate region, which comprises the whole of Central and a large portion of the plains of North India, as well as the intermediate Himalaya, which is situated between the outer narrow moist belt, and the inner arid region of Thibet.

Entirely beyond the limits of the present Flora are the southern dry region, including Eastern Mysore and part of the Dekkan, and the moist zone of Western India, comprising the Western Ghats from the Khandeish Dangs to Travancore, the country below the Ghats, and a narrow strip of country above the Ghats.

The total number of species described in the present volume is about 780; of these, three are trees new to science, which were named by Dr. Stewart, and rightly are exotics that have been introduced into India. The principle on which these seven hundred indigenous trees and shrubs are selected for description is as follows:—In arid districts, such as Rajpootana and tracts of the Punjab, every woody plant is of importance, either as a source of firewood or as a part of the scanty clothing of the parched surface of the soil, consequently every such species is described, whereas of districts where the vegetation is more copious, and especially of the Himalaya, only the leading trees and shrubs find a place in these pages. The treatment of this indigenous vegetation is elaborate and satisfactory. Under each species are given a few of its botanical synonyms, its

English name if any, and all the local vernacular names possible. The botanical descriptions are terse, and at the same time graphic and sufficiently full. These are followed for each species by more familiarly-worded details as to the general appearance, time of flowering and fruiting, appearance and quality of timber, its specific gravity and breaking strain, and the other products and properties of the plant generally. The trees forming the most valuable of the tracts in the region with which this book deals are deodar, sal, and teak, and the dissertations on these species are models of thoroughness and lucidity.

Among the introduced plants noticed by Dr. Brandis are several South American species of much interest; some of these are of very old introduction indeed, and are now thoroughly naturalised in garden and village cultivation, but are never found far from human habitations; others again occur every where. It is curious to speculate how some of these could have been introduced. The papaw,* for example, is a Brazilian and West Indian shrub. Seeds of it were however sent to Naples from India in the year 1626 or not long after the discovery of America. The prickly-pear or Cactus† of Europeans is found in waste places from Cape Comorin to Jhelum in the Panjab. Yet it is a native of America. Its rapid spread in India is doubtless due to the agency of birds which eat the fruit. Specimens of the Baobab ‡ or monkey bread, a tree of tropical Africa, are found here and there all over India. There is a fine example in the Khadar of the Jumna near Agra, and a still finer exists near Calcutta, the trunk of which girths, at four feet from the ground, 50 feet. This tree was probably introduced, says Dr. Brandis, by early Arab traders. The shrub yielding the Indigo of commerce and the stately Tamarind tree, popularly supposed to be Indian plants, are, as Dr. Brandis reminds us, more probably of African origin. The custard apple and guava are undoubtedly American, and they are in India confined to cultivated spots, or such as have been once so. The subject of introduced plants is a fascinating one, and it is almost a matter of regret that it did not fall within the scope

* Carica papaya, L.
† Opuntia Dillenii, Haw. ‡ Adamsonia digitata, L.

of Dr. Brandis' book to discuss the different weeds, such as *Argemone mexicana*, *Galinsoga parviflora*, *Oenothera rosea*, *Tridax procumbens*, and others, for which we in India are indebted to the Western Continent.

A number of plants are common to Europe and to the North-West of India. The curious *wig* plant* of the Mediterranean Flora is common in the valleys of Kamaon and Gharwal. The English forester in the middle regions of the Himalaya meets such old friends as the Hawthorn, Yew, Berberry, Ivy, Elder, Birdcherry and White Poplar, while in a more limited area he finds the unsophisticated originals of the well-known Gooseberry and Black and Red Currants of home gardens. In treating of such plants and of others, which have allies in the forests of Europe, occasion is taken to convey much valuable information on European arboriculture. Thus following the description of the tree producing the eatable fig of commerce is a most interesting account of the curious old custom of caprification as still practised in some parts of the south of Europe and Asia Minor. Dr. Brandis' disquisition on the various species of *Citrus* yielding the Orange, the Lime and the Citron, contains the outcome of much interesting research, and gives in a small compass the results of labours of many students of these historic fruits.

One notable feature in the work is, that it indicates yet unelucidated points which are worthy of observation and, enquiry. Prefixed to the volume are a useful synopsis of the characters of the natural orders to which the plants treated in it belong, and also some useful remarks on the structure of wood, and accompanying it there is an atlas (which may be procured separately) of well-executed illustrations of seventy of the more important species from drawings by the celebrated botanical draughtsman Mr. Fitch.

This book should be the constant companion of every forester in Upper and Central India, and any officer of these provinces who gets a quarter of the information contained in it well into his head, and carries it there, may safely congratulate himself as being the most accomplished man in his department with the

* Rhus Cotinus, L.

exception only of our author. What this book does so well for the systematic forest botany of a part of the Indian empire, requires to be done for Indian arboriculture generally, to which an immense impetus would be given by the preparation of a book similar in scope and plan to Lindley's Theory and Practice of Horticulture, in which the rationale of the various operations of forests, including the planting and management of young trees, should be explained *pari passu* with practical details.

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Note on the Demarcation of the Forest Area in Districts containing Hill or Mountain Ranges.

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SOME misapprehension appears to me to exist about the principles on which forest lands in hill districts ought to be demarcated. We have just been dealing with the Hazára forests, and correspondence is pending regarding the demarcation of Kángra and Kulú, and of Jhelum, *viz.*—the Salt Range forests, and the hill portions of Ráwal pindí district, also of the forests in Chamba and Basahir. Moreover, in the tehsíls of the Kángra district already demarcated, Núrpur, Dehra and Hamírpur, and in the Hoshiárpur district, certain interests and requirements have been met, but it is far from certain that the demarcations are sufficient for *all* the requirements of the case.

Throughout the correspondence no notice has been taken of the important difference which exists between the work of demarcation in Hill districts and that in the plains.

In the former case we have a set of conditions to deal with, which do not affect the latter; so much so that it is certain that what is sufficient for the plains, will not be satisfactory in the hills.

Forests have two great purposes :—First, they yield timber and other produce; secondly, they occupy a certain place in the organization of nature; and just as it is impossible to neglect certain conditions regarding circulation of atmosphere, drainage and cleanliness in the organization of towns and cities,

* This note was originally printed for private circulation, and a copy kindly put at our disposal by the Author. As the excellent principles developed in it are applicable to many parts of India, we have reprinted it in extenso.—THE EDITOR.

so is it impossible to neglect the use of forests in the organization of our hill districts, without the certainty of danger.

Now the second kind of utility of forests consists in two sorts of influence which they exercise on the air and soil. One though extremely probable, and believed in by all educated foresters, is not so certain as to be beyond doubt, and therefore need not to be appealed to as a *sine quâ non* in our demarcation proposals. I allude to the faculty of forests in collecting the rain-clouds and increasing the rainfall. Negatively we know, that drought results from denudation, but we do not know positively, that we can induce rain-fall by the creation of forests.

But the other faculty of forests we do know absolutely for certain; and therefore any demarcation of forests that ignores it, is certainly faulty and can only be partially successful; it may be briefly summed up as the faculty of regulating the water-supply of the country and preserving its soil.

Rain falls (in this tropical and semi-tropical climate) with copiousness at certain seasons, and with a varying amount of physical force. This discharge, either feeds and maintains springs, or is itself the origin of streams and torrents, which, rising in mountain ranges, flow down into the valleys and plains below.

If all mountains consisted of insoluble rock, the water flowing off with greater or less rapidity (according to angle of inclination) could do nothing till it reached the plain or valley below. But this is not the case; consequently the fall of rain affects the soil on mountain slopes by cutting into it, and carrying it down, together with loose stones and masses of rock, doing this either gradually, as where surface soil is slowly removed, or where a ravine or torrent is gradually cut and enlarged—or suddenly as when a land-slip occurs. The disturbance once started in the upper slopes of mountain ranges, augments with the accumulated force obtained by the angle of descent, and thus it happens, that small streams uniting form large torrents, which increasing in power as they flow down, influence the condition of the soil in the valleys, not only by erosion and by depositing beds of stones and even large

masses of rock, but also by causing the streams to be suddenly flooded without notice, and thus causing a great rising of other streams which receive their contents, the effects of which are felt far down into the plains, and even to the mouths of rivers, where vast alluvial bars are formed, seriously impeding navigation. On their way, such floods damage all kinds of public works, roads, railways, and bridges, and necessitate the erection of costly masonry works, embankments, dams, and retaining walls. During the winter when water accumulates in the form of snow on the upper slopes of hills, large masses are collected, which, when melting sets in, begin to slide downwards, doing incalculable damage.

It is truly surprising to find how little attention is attracted by these facts.

In Hoshiárpur, I have been told by an Assistant Commissioner engaged on Revenue work, the streams *(Chó)* flowing down from the Sola-Singhí hills are year by year cutting up and destroying more and more land; and the people are now compelled to plant masses of tall grass to arrest the progress of the ravines. *In the Jhelum Salt Range,* the torrent beds are reaching an alarming extent; and what is more, the saline deposits of the Range are yearly washed down, defertilizing the lands below.*

If we are to follow any of the notorious Punjab torrents, such as the Bhimbar, we shall find that either the main stream, or its feeders in their ultimate ramifications, start from hill-sides wholly, or almost wholly denuded of vegetation. This *fact can be verified in all cases almost without exception.*

Year after year immense sums are spent in repairing our great hill roads† which are carried away by the action of

* I may be permitted to suggest that it would be well if the Government were to call for accurate statistics as to the extent of such torrent-cut areas in these districts, and the amount of increase which has taken place in the last decade or so.

† With regard to hill roads, I do not mean to deny that where there is a steep bank above the road, trees too close are liable to fall: nor do I question that in very rare cases, the retention of a large amount of water may soak into, and so overweigh, a bed of soil reposing on a steeply inclined stratum of imperviable material, and cause it to fall down. For every one landslip attributable to such a cause, a hundred *can be shown arising from* the denudation of the soil and its consequent loosening by water action. Nor will the most able advocates for the old theory be able to contest the actual fact, which every one can verify for himself, on the Abbotabad or Simla road, that the worst ravines and road-cuttings occur just in those miles where the forest belt has disappeared from the hill side at some little distance above the roadway.

torrents formed on the steep slopes above them. Costly railway bridges and embankments are built, rebuilt and again swept away; cultivated lands are covered with boulders; lands are cut up by changing courses of unregulated streams; the bottoms of valleys are filled up with stones and boulders instead of showing rich pasture and cultivated lands, with winding clear streams flowing through them,* and we accept it all as a matter of course.

It is sometimes urged that the action of streams in bringing down soil on to the plains below is actually beneficial. An instance is quoted in the Dehra Ismail Khan district of lands whose culturable quality is annually improved by the descent of finely comminuted mud from the hills of the Sulemān series.

It is true that in this particular case benefit is obtained; for the hills never were (it would seem) clothed with vegetation, and as they are formed wholly of marl and sandy loam they are gradually and gently being washed away. Wherever a hill consists wholly of soft material capable of being discharged in this way, the results are good; and no doubt the alluvial plains of the Punjab were formed in pre-historic times by such a process. This improvement of soil is called in French "*colmatage.*" But it is clear, first, that hills consisting entirely of disintegrable soil are the rare exception; and next that in case of hills whose surface only, is covered with good soil, as soon as the supply of soil is at an end, sand, pebbles, stones, boulders and rock-masses follow, which speedily cover up the ground and negative the good at first effected.

It follows, therefore, that as it is the velocity which the water acquires from flowing down steep inclines that causes a great portion of the mischief; it is our mountain ranges, whether the higher ones like the Himalaya, or the lower ones like the Sawálik, the Sola Singhí, the Salt Range and the Pabbi hills, that call for our most earnest attention in regard to the preservation of the natural clothing of vegetation which they ought to have, and

* In Hazára—after leaving a village called Dabbin, one ascends to a hill called Thárkot; from this a bird's eye view is obtained. You then see hills sparsely covered with Chil (*Pinus longifolia*) apparently standing out like islands in a lake of blue-grey boulders. Over 85,000 acres are occupied in this district by stony river beds.

which in all probability, (nay, in most cases—in all certainty) they once did possess.

In short, while the climatic influence of forests in the *plains* is limited in various ways, and chiefly by the absence of steep inclines which give the water discharged from the earth or air a dangerous velocity; in the *hills*, it is *the* consideration which before any other we have to deal with in preserving our forests. In the plains, therefore, if we select manageable blocks of forests, free of rights, (which interfere with conservancy,) and place those blocks near roads, railways, and large towns, (thus meeting the direct utility of forests as supplying material to the market) and if further we are careful to plant swamps and retain natural forest (like the "Kachi") on the banks and islands of rivers, and then leave all the rest of the wooded area to be very slightly protected, (*e. i.*, only gradually destroyed by unlimited exercise of rights of grazing, &c., and by permissive extension of cultivation) we do all that (we can with reasonable certainty say) is sufficient.*

In other words, the popular system of "reserved" forest blocks and "unreserved" areas, so widely known in India, *may* be in the plains, a sufficiently effective system.

The mistake I here combat, consists in supposing that a precisely similar system will answer in the hill districts; and this mistake has been made (and that recently,) in many official notes and orders which otherwise show that rational appreciation of forest economy which was so lamentably wanting in years past.

When, therefore, we commence the work of demarcation in hill districts, we must first of all consider what amount of forest is needed in every range alike:—Where is the line above, or within which forest or turfed land must be maintained? IT IS NOT ENOUGH to consider solely what blocks can we get *free of rights for the State*, but what forest must we keep, perhaps assigning the *greater part of it* to the use of the villagers or other local inhabitants.

Hitherto, we were accustomed to consider only what blocks

* Assuming of course that we have calculated fairly the amount of demanded material, the probability of increase and the other conditions involved.

of forest we can get for the supply of the market, the Public Works, the Hill Stations, &c., &c. This of course must be attended to, but it is obvious that we may secure such blocks in a comparatively small number of localities, leaving whole ranges of hills untouched by such reservation. And while the forest set apart on these considerations only, may suffice to protect the hill sides and regulate the water discharge (in the widest sense of the term) *just on the sites* selected, the other hill ranges in which no such selection has been made will not be benefited; and if we give up the forest (be it timber or brushwood) on those hills to that process of sure but retarded destruction which our "unreserved" management implies, we are doing wrong, for which avenging nature will surely if slowly punish us.*

Unlike the case of forest in the plains therefore we *cannot* choose certain localized blocks of good forest and leave all the rest to the people to do as they like with as "unreserve." It is desirable that there should be no misunderstanding on this subject.

Under what sort of management is "unreserved" forest usually placed? Does that management really tend to the permanent preservation of the forest? If it *does*, then let it alone—but if it *does not* then we *must* improve it.

There may be of course varieties in detail, but generally speaking it comes to this: that "unreserved forest" is to be left

* At this stage it is desirable to say something about the use of *turf* on mountains. Those who have taken an interest in the question of the denudation in the Alps, an evil which assumed such alarming dimensions that at last in 1860 legislative interference was called for, and laws for effecting the "reboisement" (or re-clothing with wood) the necessary portions of hill ranges were passed, will recollect the discussion which arose, as to whether the absolute planting with trees was needed, or whether the consolidation of the soil by turf (an operation called "*gazonnement*) was not sufficient. It had the advantage of not interfering so much with the grazing of cattle (which there, as here, was the chief obstacle to forest conservancy) as the planting of continuous masses of trees.

I cannot here enter into the discussion as to whether (even in Europe) "gazonnement" is a really sufficient remedy. Some have denied it: on the whole, however, it would seem that turf (including a dense mass of bushes and other vegetation) is in many localities, at any rate sufficient.

We have, however, in India, another point to look to.

In the Alps and Europe generally, the grasses are of different species as a rule to those found in our semitropical climate. It is only in our very high ranges and usually above and beyond the limit of tree vegetation that close turf forming European and Alpine species predominate. In our Indian Ranges (except the highest) the grasses grow more in tufts or crowns, so that the rain falling with violence between the tufts, attacks and eats out the soil; thus the grasses of these species do not efficiently protect the soil in many cases.

open to the *unrestricted use and enjoyment of the people.* Phrases descriptive of this class of forest, couched in these or similar words, will occur to every one. This use and enjoyment is very generally regulated only to the following extent :—

(*a.*) Certain valuable trees are not to be cut at all.

(*b.*) Other trees are to be cut for agricultural and domestic use (including fuel) without restriction, but large trees for building, &c., are granted (free, or at reduced rates) by *permit* issued from the District Office.

(*c.*) Breaking up of land is allowed on permission of the District Authority; this permission is usually refused *if it is known* that good trees or forest are on the land.

(*d.*) *Grazing of all kinds of animals (goats and camels not* excepted) is absolutely unrestricted (may be paid for or not, that does not affect the preservation of the forest.)

(*e.*) Burning is sometimes prohibited, sometimes not.

In places where practiced, "khill" or "kúmri" or "dahya," or "toungya"* cultivation is partially restricted.

(*f.*) Usually the people are to use the produce, &c., for themselves, but are not allowed to *sell* it to contractors, merchants, &c.

On this, three things appear :—

I.—It is clear that unless the amount of material taken out of the forest in the shape of trees and fuel does not exceed the amount annually produced, the forest capital or stock will be reduced gradually, and ultimately destroyed.

It is also clear that in unreserved forest, the authorities are not furnished with any principle, or with any means of knowing what the yield can really be. There is only a *chance* that by refusing some, and reducing in amount most, permits, they *may* be within the limits of proper yield; this chance is *less*, the fewer mature trees there are and the poorer the forest is.

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* By these names is known in different parts of India and Burma, the method of cutting down a plot of forest,—burning the dried material, digging the ashes into the ground, and cultivating the spot for one or two crops; after which the cultivator moves off to another spot of virgin forest, (or forest that has recovered itself) and begins again.

II.—As regards cultivation; there is only the same *chance*, that the gradual reduction of the forest area by cultivating permits *may* be proper; the *less* the area of unreserved forest, the less the chance.

Again a given area of cultivation—clearing which might be allowable in one situation, may become very improper in another.

It is urged, however, that the position of the area applied for can be ascertained from the village map.

Even if in every case of breaking up for cultivation (which generally proceeds by little bits at a time in hill districts) we were sure that the irregular little plot *was* pointed out to the District Officer on the map, so that he could refuse it on consideration; even if this *could* be done, it must be admitted to be a troublesome way of doing what could be done more effectually and more simply in another way, *viz.*, fixing a line beyond which cultivation may *not* go, but within which it is allowable at the pleasure of the owners (subject only to proper notice for revenue purposes.) In practice, permits to cultivate in each case are not, and cannot be, looked into minutely enough to do any good. The plot broken up is usually, (as I just observed) at first a small indefinite patch. The area is not known, and its position not correctly indicated. No limit is placed practically to the area broken up when a permit is once issued. If a dermarcated line on the ground is fixed, cultivation cannot take place on the wrong side of it without discovery at the first inspection.*

III.—That grazing being unrestricted, the restoration of the forest by coppice or seedlings to replace the material that is removed, cannot possibly occur, otherwise than partially and imperfectly, and in out-of-the way portions of the forest, where the cattle do not come; and the larger the population and the more numerous the cattle

* Of course proper inspection, and a proper establishment are the *sine quâ non*, for any system whatever.

(especially where goats abound) the more imperfect and the more partial will the restoration be.

Where burning and "dahyâ" *cultivation are allowed, the* chance of the forest is indefinitely made worse.

From these three considerations it undeniably follows, that the general idea of management involved in the "unreserved" system can only be sufficiently successful in practice;

(1.)—Where the area of forest is very large and proportionately well stocked, and when the population and cattle are also *proportionately not numerous.*

(2.)—Where *also* the District Officer takes a very great interest in the forest, has taste and time to visit it himself, punish strictly all acts of waste and destruction, and *is not obliged to delegate his authority in the matter of 'permits' to subordinate native officers, who again delegate it to village watchmen and the like.*

As in most of the hill districts in the Punjab the first condition does *not* exist, and as regards *time* and opportunity, the second exists only to a limited extent, it follows inevitably that the "unreserve" system (as it is at present in vogue) does *not* suffice to secure the proper preservation of those forest lands which are not taken up as "Reserves," and which I have already shown *are* necessary to be preserved in hill districts,* though they may not be so in the plains.

The *rationale* of the failure of the "Unreserve" system under such conditions, is that it is *based upon mere guess-work* (however intelligent) not upon any actual examination of the ground itself, or upon an estimate of its capability; so that when a District Officer's hands are full, where the population is numerous and the demands for cultivating and tree-cutting permits numerous also, it is impossible for him to check

* In Hazara, the Deputy Commissioner and Settlement Officer remarks:—"The "total waste area being 13,98,748 acres, of which only 11 *per cent.* is reserved forest "and 75 per cent. is other hill waste, no argument is needed *to show the importance* "of retaining an efficient control over the unreserved wastes."

In Kángra a late Deputy Commissioner defending the district management warmly, on the ground of the influence of the *District Officer* being paramount, admits that large areas of forest have been cleared, and that the supply *(even)* of timber is threatened. In the demarcated tehsíls of Kángra and Hoshiárpur, though the works carried out with great skill, probably *settle* the question *of supply of material*; it is *doubtful whether areas are sufficient to protect* the district in other respects. In Hoshiarpur it is negatived by actual facts.

efficiently the issue of such permits, having neither *data* regarding the condition and contents of the forests, nor principles to determine the limits of the possible area of cultivation. Even if by the careful understanding of the sort of places on which cultivation ought to be prohibited, he laboriously checks every application with the village map, and is further assured that the cultivation is of that extent and area which is applied for and no more, and thus saves his forest land from conversion, he may nevertheless issue permits for *cutting* in the forest to such an extent, that the material being exhausted, a long period must intervene during which no wood is obtainable, the ground being either bare, or covered only with young growth demanding years for its development to useful size.

It is sometimes proposed to remedy this difficulty by issuing a set of local *rules* to regulate the issue of cultivating, and tree-cutting permits: but in the former case the rules can only define certain conditions, under which cultivation is not to be allowed; and the simpler way is to cause the line to *be laid down on the ground and entered on the village "Shajras."* In the latter case no rules can be a substitute for the one and only way of regulating cuttings;—*viz.*, an examination of the forest, and an enumeration of its stock, by one or other of the known methods of forest-valuation.

If so much is admitted, as I think it must be by any one who will candidly examine the subject (throwing aside the prejudice which has grown up in favor of a too easily excepted and *primâ facie* satisfactory system,) a difficult question arises for solution which may be thus stated:—'All forest conservancy comes in contact with the prejudices of the populace by requiring to a greater or less extent, the restriction, or even total cessation of many practices which they are accustomed to, and the exercise of which they look on as a matter of right, while totally ignorant of the mischief those practices entail.—' 'Our plan has consequently been to restrict our conservancy to certain defined areas, and allow the rest of the forest to be open to all such cherished practices;—thus we solve the difficulty off hand. When, therefore, you say that those areas are insufficient, you compel us to interfere with the people's practices

to a much larger extent even possibly to the extent of embracing the entire area of forest land in a given district; this would involve an amount of popular discontent which we are not prepared to face.'

When this argument is stated to persons in authority, who have a limited or comparatively weak faith in the reality of the mischief done in ever widening circles, by forest destruction,* as indicated in the foregoing pages, they will at once *over-rate* the amount of *local* inconvenience suffered by the limited population in the hills, and *under-rate*:—1st, the benefits to those very people themselves which can be given in return for the restriction; and 2nd, the benefits to the country at large; the cessation of dangerous floods, the extended area of culturable land, the absence of erosion and diluvion, the safety and cheap maintenance of roads, bridges, and public works, which are the direct and indirect advantages to be set off against the inconvenience. They over-rate the one because it is palpable, though often exaggerated and expressed in highly colored terms (if officials are found willing to listen;) they under-rate the other, because they only partially believe it, or are unable to trace the facts to their true explanation. If then we are able to establish the real evil and get people to realize it, they will come into a different frame of mind when looking at forest questions, and will be prepared to feel that somehow or other the necessary conservancy *must* be effected, and will cheerfully set to work to see how it can be done.

The complete illustration and proof of the evil cannot be attempted within the limits of a mere paper like this, but the considerations already advanced cannot be without weight. If violent tropical rain falls on a surface either bare of vegetation, or protected only by sparse tufts of grass and occasional bushes, it follows that the soil must be cut away; first a little gutter or channel, then a deeper ravine is formed. The water begins to rush impetuously in a turbid stream along this, then stones and mud fall in, then larger stones; and as the fall goes on, the increased velocity and mass urge the destruction more

* See a paper on popular aspects of forest conservancy in the "Indian Forester" or July 1876. (Calcutta "Central Press Company.")

and more powerfully, till huge boulders are carried along and masses of earth swept away, which when the flood subsides, no one would suppose could have been moved by such agency.

This is repeated in numerous little channels all running together, according to the configuration of the hills, till they unite into one big torrent which sweeps with resistless force through the valley below—and into the plains beyond.

If on the other hand the land is covered with trees, first there are the spreading branches, leaves and twigs to arrest the fall to break its force, to absorb part of it and cause it to remain suspended till evaporation takes place; then there is the mass of dead leaves, moss, and soil under the trees, the absorbent power of which is truly marvellous, and fortunately for us has been the subject of exact scientific observation.* The roots of the trees below the soil again have a powerful effect both in combining the soil and in absorbing moisture; in this latter respect exercising a powerful influence on the regulation of those under-ground springs, which sometimes start landslips in the shaly soil so abundantly found in the Himalaya. The water not absorbed is gently given off in clear streams, and is compelled to discharge itself slowly, the force of its fall having been thoroughly broken. That which is absorbed is slowly returned to the air by surface evaporation or is imbibed by the trees and plants and descends to feed springs and keep the sub-soil moist.

To show how the preservation of forests and the reclothing of verdure (which in many cases nature will effect herself by rest and protection for cattle) will stop these torrents, close

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* GERVIG, of Karlsruhe, has made experiments showing that 5 parts of ordinary forest moss and soil can absorb 30 parts of water in ten minutes, which is equal to a column of water of 4·466 millimetres, or 0·1756 inches. In mountain forests where the moss and soil are deeper, the column of water thus detained was found to reach 10 millimetres. If we add to this the large amount of water absorbed by the lower soil (sub-soil) it has been found that 2 to 3 centimetres, or under favorable circumstances even an inch of water has been absorbed. An area of 16 square miles of forest can absorb and retain 43—64 *million cubic feet* of water which would otherwise have rushed down the bare hill sides. (Forest conf. 1873, p. 97.)

In France in the department of Meurthe two streams the Zorn and the Bievre were selected, each situated on similar soil, slopes, &c. The basin of the one is wooded, of the other nearly bare. Observations made on the superficial drainage or flow, and on the increased flow of the stream after a given amount of rain-fall (equal in each case) show co-efficients of force of action not far short of double in the denuded basin and stream, what it was in the wooded. Too much stress must not however be laid on this conclusion. The experiments require to be multiplied. It is only fair to note that another experiment made by French Engineers gave different results.—B. H. B. P.

up ravines, and consolidate land slips, it is necessary first to observe the mountain sides, intelligently, in view of these considerations, while touring in the hills; and secondly to read such books as Geo. Marsh's "The earth as modified by the action of man" (Sampson Low and Co.) and Dr. Croumbie-Brown's "Reboisement in France" (H. S. King and Co.) with notices in "Humboldt's Cosmos" and other works.

Here I can only repeat that the action of forest in regulating the action and supply of water—as affecting not only the hills and valleys themselves, but the districts far away in the plains—or is the most prominent use of forest in hill districts, and the chief one to be remembered in determining the extent of forest to be preserved; and that this is no doubtful or fanciful theory of foresters; it is one of the most certain and practical of the results of forest science.

It may be added, that if nature has clothed the hill tops and sides almost invariably with forest, it was for a wise purpose; and we cannot to any great extent upset the arrangement without disastrous consequences. Of course this last argument has its limits, because we see countries where the tropical vigor of vegetation covers *every* spot, hill or plain, left to itself; and here obviously, a partial (but never a total) clearing is necessary for man's place in the scheme.

To gain a full and hearty assent to these considerations, which (from reading the notes and opinions and correspondence on demarcations in the hills of the Punjab appear to me to be probably new to many, not only in official circles generally, but even in the Forest Department itself) is the first and most important object.

Once gained, it will cause us to look in an entirely new light on the hardship to the population that immediately surrounds the forest which is the object of our solicitude. We shall be led to ask 'cannot we draw a line somewhere, *outside* which people can still do as they please; and cannot we while restraining their action *within* that line, let our interference produce such good results to their pecuniary and other benefit—that they will before long be quite reconciled to the restriction?' In other words 'we have hitherto accepted without further

enquiry the idea that we can only preserve a little forest and let the bulk go almost unrestricted to the people; is there no better plan that this?' Is not the principle of consoling the people by giving *them the income to enjoy, not the forest itself to destroy* at least satisfactory to them?

To determine this, let us examine the old 'permit' system more closely. The chief reason why it acts so easily, is that it is *rarely* enforced fully. Permits are given very easily; they are also easily exceeded or evaded, and so the system is not as much felt as it would be, if really carried out. Of how many codes of Forest rules for "unreserved forest" *can it be said that all its restrictions are always fully acted on?*

From our former observations we have seen that the principles on which such rules are based, do not really provide for the efficient conservancy of the forests, and that they *cannot* be carried out properly by reason of the want of time and opportunity, and the absence of data and information as to facts; we may now see also that even if it were strictly carried out, the old system would inflict a *good deal* of trouble on the people, and that sometimes unnecessarily.* For instance why should a man go twenty miles to a tehsil for a permit for cutting, say, ten trees, if it were *known* that either the forest could properly yield it (in which case no permit would be wanted) or that it could not, (in which case a permit ought not be granted)?

Again it is essential, under a system which imposes the restraint of permits issued really by guess-work, that *sale* and *profit-making* should not be allowed,—the village owners must only take what they want at *their own use.* If the forest can really yield more, why should they be debarred from selling it?

Now if we return to the requirements of forest conservancy, and see what restrictions we really need to impose, we shall be in a position to compare them with those imposed by the

* In some codes permission is required to break up land for cultivation *if it bear trees*, and (very absurdly) is not required if there are no trees. If a man wishes to cultivate he has either to get a permit or destroy the trees first, so that he may say there are none! This distinction offers a direct temptation to people to destroy trees.

old system; (supposing it to be enforced), we shall be able to strike a balance between our proposed system and the old, in point of convenience.

In the first place what improvement is possible on the system of governing the unreserved forests by permits?

We have to provide for the maintenance of the unreserved forest, at the same time meeting the wants of the people as regards extension of cultivation and grazing.

We can dispose of grazing first. It can generally be provided for within the forest area:—

(1).—In forests of trees so aged as to be out of danger.

(2).—In places within the forest limit which are turfed only—or having patches or belts of trees, left on them, thus combining the use of forests and grazing ground.

This method so largely adopted in the Alps, demands very careful consideration in the Himalaya, wherever the grazing question presses; it is by no means difficult to arrange something of this sort, which provides for the cattle, while enabling the area to fulfil to a sufficient extent the function of forest.

(3.)—It can be practised in the option of the villagers in any lands *outside* the forest line, and they must decide in their own interest, whether they will cultivate all the land or keep some part of it for grazing.

I beg here to impress on the authorities the great value of statistics of cattle. Not only should we know what number of head of cattle of all kinds the people possess, but also we should learn how many acres per head are needed, on good, fair and indifferent ground. When we speak of the "grazing requirements of the people" *without knowing these data we are really* only going by guess.

Where cattle are *so* numerous, that all the provision we can make within the limits of the forest area, are insufficient, then the people themselves must consider (the 3rd case, *viz.*,) how they break up the land outside their limits for cultivation, and must decide between the profit to them of cultivation and grazing; there is a limit beyond which neither one or the other can possibly extend.

We are now free to consider what land must be kept as

forest, and what may be cleared for cultivation (subject only to the consideration last broached.)

As the dangers to be guarded against are avalanches, landslips, erosion of soil, and torrents or ravines—and as we have also to preserve the water in existing springs and streams, it follows that on all hills forest land must be maintained;

(1.)—On the sharp crests or summits of hills, and in a belt along the top.

Where the top is an undulating or flat surface, it may be cultivated; in that case a belt of forest on the verge of the slopes of the hill just below the undulating summit, must be kept.

In these cases the width of the belt is determined by local inspection, and by the relation of the belt with other circumstances mentioned below.

(2.)—On all steep slopes, say of 50° and over. If these are bare or cultivated, soil is sure to be washed off, and landslips to follow:—Any one's experience of a hill tour will confirm this.

(3.)—The fan-shaped hollows, basins or amphitheatres from which the ultimate branches or feeders of streams and torrents take their rise. This includes the sources of all streams and springs.

(4.)—The banks of ravines, torrents and streams, down to their junction with the stream at the bottom of the valley.

If therefore a *line,* which I may call the "compulsory forest limit," were drawn along every hill range, taking in these four conditions,—we should have a proper protective belt of forest, *outside* which it is immaterial on climatic grounds what is done with the soil.

(5.)—Practically, however, to these four conditions we must add a 5th on economic grounds; *viz:* that where, *outside* these conditions, there are blocks of forest, which owing to the value or interest of their trees, or from their obvious utility to certain villages or to the market supply, it would be undesirable to destroy or clear away, the forest is here also to be kept up.

The 5th condition differs in this respect from the other four, that while they are absolute, and forest must *always* remain in such places; the economic value of the 5th may in course of time cease, and therefore the rule may be expunged along with the necessity for it, *e. g.*, when the forest under the four conditions is so well kept and contains a sufficient supply of material so that nothing more can be needed, the forest originally retained under 5, may gradually and entirely disappear without danger.

If then in every hill range we demarcate by natural marks or by pillars, the line* which includes all this forest, it is obvious that the same line on the other side will indicate the area within which *cultivation may be extended.*

For such extension no permission need be asked; only the Revenue authorities will need to be properly informed of the intention to cultivate, and will make such orders (totally unconnected with forest interests) as Revenue requirements may dictate.

Here is the utmost simplicity and the first great boon to the people.

(*a.*)—It will be unnecessary to go many miles for a permit, with a chance of refusal.

(*b.*)—It will be unnecessary to pay any one for settling the permit to cultivate.

(*c.*)—It will inflict no labor on the District Officer—either to try and trace the spot on the map, and be sure that the position is a proper one; it will supersede the necessity for a repeated visiting the localities after once the careful local inspections necessary to fix the "line" has been effected.

(*d.*)—It will be impossible to evade the law, for the inspecting officer seeing that any patch of cultivation is on the wrong side of the line will stop it at once and apply the penalty.

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* The old French Government in the Mauritius adopted a similar plan—only they fixed a more arbitrary line, *viz.*, they reserved the upper *third of every mountain as* forest, and prohibited clearing thereon. This was a simple plan, but sometimes it would include too much forest, and sometimes (as in the case of ravines extending down the mountain side) not enough.

(*e.*)—As the forest above the "line," (where it is not reserved as Government property,) will be village land, the whole income, produce and yield of which belongs to the villages, they will come soon to regard the "compulsory line" as one for their own benefit and not as bringing into contact with them, an alien and adverse property.

But some readers, before they have had patience to read even so much, will exclaim, that this looks all very well, but that in practice, we are not going into a virgin country with nice forest of one sort or another ready to be carved out and aligned, but we shall find that when we attempt to draw our "compulsory line" villages will already be found perched on the steep slopes, and that cultivation has encroached on the forest, and whole tracts of forest have been destroyed by excessive grazing—showing only stony slopes with stunted bushes and patches of grass tuft; and as for ravine banks, they will exhibit great slopes of loose earth and stones ready to come down next rains.

All this is perfectly true. I have only to say, that it is no reason against a right procedure, that you cannot act on its integrity. Still keep your idea of 'the line' and do your best, and you have these remedies to help:—

(1.)—Take all the waste land inside "the line" whether turfed, bare, or illused.

If it is turfed, by arranging to close a bit of it at a time, you may get natural growth on it, or even get some rough sowing or cheap planting done,—especially you may gradually reboise it in belts or patches, so as to allow free circulation of cattle between the belts.

Bare banks of ravines taken up, will soon clothe themselves with bushes and vegetation enough to be of great use in consolidating the soil.

In the Himalaya *mere rest and protection do wonders.*

(2.)—Look into the cultivation (often temporary and very worthless) that encroaches on 'the line;' in some cases it has been cleared utterly in contrariety to the previously existing law, so that it can be summarily

stopped after the existing crop if any, has been removed. In other cases it may be possible to exchange it for land below.

(3.)—In cases where such cultivation is on steep places, codes of rules should always *have a provision enabling the* Deputy Commissioner to order the owners to build up or bank up, or terrace the land.

In other cases, the evil will cure itself. I have seen much cultivation in Hazára (*e. g.*,) that will cure itself. Every inch of soil will be washed off in 2—3 years, and probably a landslip or a ravine will end the story.

(4.)—In very bad cases of danger from landslips, &c., apply the principal of expropriation for indemnity.

Then assuming that we have got the line drawn partially, but as nearly as circumstances will admit, how is the treatment of the forest, bare land, and bushy or grassy slopes, of which it is made up, to be managed? If it is treated as strictly as a Government reserve, what are the people to do? If it is left open without restriction, it will become as bare as if it were cleared for cultivation, and be the source of all the evils which the clothing of forest is intended to prevent. How will the convenience of the people be met as it is by the "unreserved" or (permit or gradual destruction) principle?

I answer that you must manage the forest on proper principles, taking the *simplest, easiest* and least expensive method possible for the purpose; or in other words adopt the system *of working by a plan, but reduced to its simplest and most* elementary proportions. The management must be based on an actual examination and estimate of the stock of the forest, and the annual yield must be laid down for a few years, and the principal things to be done in the forest must be embodied in a written document, framed free of all technicalities, and deposited with the village forest official for guidance.

The document will simply state:—

(a.)—The number of marked trees which may be felled annually; these may be allowed to accumulate, but must never be exceeded, and they must be marked.

There may be permission to lop these trees and to bark them or bore them for turpentine before felling.

(*b.*) The parts of the forest from which grazing must be excluded to enable it to grow up.

(*c.*) The kinds of trees which may be lopped for fodder or cut for fuel, and the block or yearly portion of the forest in which this may be done.

(*d.*) The area of brushwood or coppice that may be cut.

(*e.*) The places and conditions of lime, "surkhi," and charcoal burning.

These simple regulations have to be carried out, and there must be a system of monthly reports by the village officials responsible.

All the produce of the forest so prescribed, all the grazing or grass cutting in the forest is to be at the absolute disposal of the village to use or sell exactly as they please.

There will of course be the usual code of general forest rules prohibiting forest offences, fires and mischief.

It is essential that a competent Forest Officer should be temporarily posted to the District (under the Deputy Commissioner) to examine the village forests, demarcate "the line" and draw up the orders for the yield and management of the forest. The cost of employing this officer, Government ought to bear, though ultimately a percentage may be taken on the forest produce. At first this ought not to be done in order to popularize the system, as before remarked. If this assistance is refused, it will be exceedingly bad economy, and can only result from a want of belief in the importance of keeping up the village forests, and from failing to recognize, that where we want to keep up the "massif" of forest, *we must only take out trees on a counting or valuation*, and that the attempt to take them out by issuing permits without such a previous check, is a radically faulty plan, applicable only, as before observed, where the area is very large and the population comparatively small.

A small forest establishment can be kept up for each tehsíl aided by the Revenue Establishments (of tehsíl Chuprassies, Patwaries, &c., &c.)

At first I would have it all paid for by Government so as to make no charge on the forest.

The control over the forests is thus compensated for by allowing the people to derive a real profit from it, and I wish it to be considered whether this profit is not as real an advantage to the people as the old method of leaving the forest free to them subject to permit-restrictions and the prohibition of sale or merchandise.*

It is only a question whether *Government* will prefer to secure the contentment of the people by incurring a very moderate expense, or will prefer to purchase that contentment by the destruction of the forest at no monetary expense to itself.

It would not do *at once* to charge a percentage on the forest produce; for that would take away the *quid pro quo.* We give all profits as a set off against the restraint.

If it is asked—"you say, there should be no charge on the forest *at first* why not permanently relieve it?" I reply that in time when people have come to appreciate the restraint as the direct cause of permanent profit to them, and when the results of fair management have been to increase the profits to a considerable extent, it may ultimately become quite right to maintain a better agency for supervision and require the forest produce to pay a share of the cost.

It is now time to consider how it is possible to carry out a valuation or counting of the forest, which is the *backbone* of the suggested system of management.

It may be done by various methods, but I recommend as a rule the adoption of the method proposed by Dr. Schlich,† *viz.*, laying out a line and measuring 50 feet on either side of it. On this space all trees should be counted. The linear samples should be so numerous as to be at least 2 per cent. of the whole area.

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* An instance may be given from Hazára experience. The people have a sale for "Excelsa" bark; they can get Rs. 3 for the bark of one tree, but under the old system they may use for themselves but cannot sell,—therefore they have to pretend they want the trees, get a permit to cut, and then sell the bark quietly.

† This method was originally introduced by Dr. Brandis, and only modified by Dr. Schlich.—THE EDITOR.

I should for the present treat the trees by classes :—

(Not enumerated)	Seedlings	(under 1 hâth) = under	18″—I	class.
	Saplings	(1—2 hâths) = 18″ to	3′—II	„
	Young trees	(2—3 hâths) = 3′ to	4′ 6″—III	„
	Trees	(3—4 hâths) = 4′ 6″ to	6′—IV	„
	Old trees	(4 haths & over) = 6 &	over—V	„

The following remarks of Mr. Amery, Deputy Conservator of Forests, extracted from the "Indian Forester" of July 1875, seem to me to be worth quoting on this subject. He writes :—

"The most important factor in this operation (*viz.*, counting trees) and that entailing the most labor is ascertaining the girth measurement (may be taken at breast height, or say 4 feet above the ground, B. P.), and this can be as well performed by a native writer on 10 rupees a month, aided by a chaprassi on 5 rupees as by the most scientific European."

"A party of twenty such couples, the writer armed with pen and ink at his girdle, and a book in his hand, and his assistant with measuring tape in one hand to help in measuring, and a paint-pot and brush in the other to mark the measured trees, would get over a considerable area in a day, chronicling the class and girth of every tree; while the officer in charge of the party would take and register height measurements for age-class (this we should not attempt, however, in the unreserved forests, B. P.), and stock his note-book with observations on the general condition of the block, soil, undergrowth, reproduction, &c., &c.; he should be attended by a couple of coolies, with a chain for the rough measurement of compact blocks of saplings below the minimum girth measured."

Mr. Ribbentrop has also described a method of counting in the Conference of 1872—(page 191,) but this relates to exceptional cases where *all trees* are counted. It may nevertheless be given.

"A line of men is formed consisting of alternate measurers and writers extending at right angles to the boundary line (of the forest, or of the block); the former takes the girth of the tree which he calls out, and the latter immediately enters it on his book. At the end of the line of men, a blaze line is cut on the trees by a marker. This line corresponds with the boundary line as they return."

Thus :—

Boundary.
I Measurer.
O Writer.
I..............
O..............
I..............
O..............
I ....
O..............
P. Marker cutting blaze line.

"Practice will make it an easy task as soon as the people become accustomed to the work."

The measurer for unreserved forest will only measure the trees of 2nd, 3rd, 4th, and 5th classes, the number of seedlings being noted generally. When they come to a patch of seedlings or poles, this may be described, or chained off.

If it is intended to disregard trees other than *conifers*, or trees of valuable kinds, the others will be omitted in counting, and a general note made regarding their abundance or otherwise.

A calculation of numbers will enable the entry to be made in the simple "working order" drawn up as to the number of trees to be cut.

The *one* real difficulty to be overcome is ascertaining the rate of growth.

We want to know roughly for unreserve purposes, in how long the counted number of old trees, will be replaced by an equal number of younger ones. Supposing x = number (counted and estimated) of old trees—*i.e.*, trees of a size admissible to cut, and a to be the number of years, requisite to allow an equal number of young trees to come to cutting maturity, the yield or number to be cut in a year will be $= \frac{x}{a}$.

When thinning has to be effected, it must be done on opportunity occurring of sending a proper forest officer to the spot.

What *size* the trees to be cut are, whether only 1st class or some of other classes,—will depend on the state of the forest. All trees to be cut must be *marked*, say for five years' cutting ;

each year being one-fifth of the number, exclusive of trees of inferior kinds which may be cut according to general directions without limit.

Then the whole of the produce is at the disposal of the village.

Will not people gradually prefer this, to a power of user limited to their own wants, coupled with a total prohibition against making any profit?

The question which remains is, who is to get the income? If it could be made into a communal fund that would be *the* way to show people what the forest was worth.

First of all, the necessary firewood and other material is assigned by the community to the use of each person, and the rest is sold. If only a few rupees get divided out to individuals, they do not know what the total produce is, and they under-estimate the value of the forest accordingly.

If, on the other hand, the amount goes to a common fund, they can improve the condition of the village by building wells, tanks, "ziárats," schools, mosques, roads, &c., and add to their "malba" (or other similar common fund) for joint purposes.

This I firmly believe to be the only way of popularizing forest conservancy and improving on the system of handing over forests to be destroyed by unrestrained use.

The only objection that can be raised on the other side is that the system is not complete enough, to fully effect the object. I can only answer that half a loaf is better than no bread. The system must be reduced to the last limit of cheapness and simplicity, or it will not be carried out; and that even imperfect as it may be, the system is so much better than the old one, that it ought to be accepted as at least an instalment of right action, and may pave the way for greater exactness hereafter.

It only remains to express a hope that, when a survey and settlement party take up the question of reservation in Rawalpindee, in Jhelum, and Shahpore (the Salt Range) in Shahpore-Kundi, and in Kangra, they will set themselves not to consider only "blocks worth preserving by the State," but first deter-

mine a general forest line as nearly embracing the five conditions above specified as circumstances will allow, and *then* proceed to consider what part of that they will retain for the State. If the wants, rights, and privileges of the people are pressing, rather give the whole right and income to the *communal* body, than abandon the forest itself to destruction. If the rights of the State are so few that you do not feel justified in taking up any land—keep the forest and give its income to the people, but not its area to destruction as an "unreserve."

Remember also sec. 48—50 of the Punjab Laws Act IV of 1872, which provides that in all cases the use of natural products in Government land (*i.e.*, not land the proprietary right to which has been alienated) is subject to regulation.

APPENDIX.

While these sheets were passing through the press, I received the "Revue des Eaux et Forêts" for July 1876.

This gives a summary of the new Federal Swiss law, published 29th April 1876, applicable to all the cantons of Switzerland or such parts of them as contain mountain forests.

It is to me a confirmation of the reasonableness of what I have urged regarding our own demarcation work, to observe how the provisions of this new law run.

After reciting (Art. I) the general surveillance of the Confederation over the forests in the elevated regions of Switzerland, the law goes on to indicate the cantons to which it applies; and in all these the local authorities in concert with the Federal Council, are to determine the extent of territory to be under general surveillance and within the scope of the law.

All *state and* communal forests in that area or extent of country, are under surveillance; *and also all private forests when they have the character of 'protective forests'* (forêts protectrices.)

By Art. IV, all those forests are defined to be protective forests, "which by reason of their elevation, their position on abrupt declivities, on culminating points, on ridges, on the brows of hills, on spurs, in the region of the sources of streams, in defiles, in ravines, on the banks of rivers and streams, or those which by reason of the otherwise insufficient forest-clothing, serve as a protection against climate influences, the ravages of wind-storms, avalanches, falling stones and ice, the detrition of soil, landslips and erosions, torrents and inundations."

By Art. V, each canton is to determine or effect a separation between those forests which are protective, and those which are not.

[I may here note in passing the *obligation* imposed by Art. IX, on the cantons, to provide for the formation of a sufficiently qualified staff of subordinate employés, by means of a course of instruction in sylviculture or forest management.]

By Art. X, all forests are to be demarcated (délimité) within five years.

Art. XI.—Within the demarcated limits, the forest area may not be diminished without orders of the cantonal authorities, and the sites of cuttings and blanks must be always replanted or reboised, unless an equal amount of land has been planted elsewhere. All clearing or breaking up of forest or cultivation is prohibited in protective forests, or in places where the clearing would endanger the existence of a protective forest in the vicinity.

Art. XIV.—Provides for buying out dangerous rights, which is compulsory, if the rights are incompatible with the existence of the protective forest. The buying out to be effected by money payment, or the exchange of lands.

No *new* rights can accrue in the forests.

Art. XVI.—Provides that the possible annual yield of the forest *shall* be determined, and cannot be exceeded without especial Government authority; and if it has been so exceeded, by authority or in an illicit manner, the yield of the subsequent year is to be reduced in proportion.

Art. XVII.—Deserves to be quoted at length :—

In forests for which it is not possible at once to lay down a complete working-plan (aménagement définitif), it is necessary within the five years following the promulgation of the law *to determine by a preliminary working-plan the figure at which the possible annual yield may be fixed:* also the mode of working, regenerating, and taking care of the forest.

Art. XVIII.—Provides that the cantons have authority to regulate the working of private forests under the circumstances which this law describes *(vide supra.)*

Art. XX.—Provides that all utilization of minor produce of such a kind as interferes with proper management, such as grazing, collection of mould and dead leaves, &c., may be either *confined to certain limits* (cantonné) suspended or suppressed altogether.

Arts. XXI, XXII.—Provide that lands which are urgently wanted to form important protective forests, may be planted on the requisition of the Government. If the land is private property, it is expropriated for indemnity.

The fifth chapter of the law, Arts. XXIII—XXVI, is taken up with the works which the Confederation will subsidize or assist with funds:—such are the instruction of persons to fit them for forest service, works of reboisement, &c.

The sixth chapter deals with penalties. That for diminishing the forest area is from 100—200 francs *per acre,* and compulsory replanting within a year; for exercising rights contrary to Art. XX, 5—500 francs.

The seventh chapter contains miscellaneous provisions with which we are not concerned. This abstract I have thought instructive, as justifying the remarks I have made, and showing how fully these principles are recognized in Europe.

Subordinate Forest Establishment.*

By C. F. Elliott.

It appears to me that the subordinate establishment in the Forest Department is not at all on a satisfactory footing, either as to the stamp of men employed, or their treatment, and duties, their relations with their superior officer, and with each other, &c., &c.

In the hope of opening a discussion which may lead to a greater uniformity in these points, I venture to make some remarks on the subject.

I. Beginning with Rangers, I would state my conviction that it is a mistake to employ Europeans in this grade. As a rule, Europeans who will take up these appointments, without hope, be it remembered, of obtaining any promotion, are such as have no respect for themselves, and fail to inspire any, in the natives in general, and their immediate subordinates in particular.

They are, almost invariably, persons utterly without education, and frequently not nearly so intelligent as natives on half their pay.

There is only one way of employing European Rangers in this country with advantage, *viz.*, where a definite stationary charge can be given, such as a timber sale depôt.

To place a European on Rs. 50 to 200 per mensem out in charge of forests, or rakhs, with an order to keep a general supervision over the whole, appears to me to be folly.

He will not travel about in the hot weather as a native can, and he *will be probably no more observant, or intelligent than* the Foresters under him; while it is utterly impossible, as far as my experience goes, to get out of any such person a report explaining the state of the forests, whether improving or deteriorating, whether fit to be further worked, or already overworked,† &c., &c., and he is totally ignorant of both English and vernacular names of any but the most common trees and plants.

* We print this paper, not because we agree with all the views put forward, but in order to invite discussion of this most important branch of forest organization.—The Editor.

† This of course is only necessary where no working plan exists.

Therefore, supposing all the subordinate establishment to be composed of natives, I would make the Rangers' grades thus: Rs. 50, 75, 100, 150.

We have now arrived at a stage when our native officials should have a recognised status, as in the civil and police departments. Thus, I would make those on Rs. 50 and 75 equal in position to Deputy Inspectors of Police and Nâib Tahsildars: those on Rs. 100 and upwards, equal to Inspectors of Police and Tahsildars, and they should be addressed with the more respectful "âp" and receive a chair, &c.

There should be a greater difference in pay, than at present, between Foresters and Rangers, and between Foresters and Guards, while at the same time, there should be sufficient distance between the steps in each grade to allow of fair promotion.

Foresters should be graded on Rs. 20, 25 and 30, abolishing those on Rs. 15 and those above Rs. 30.

There should always be 4 classes of guards, *viz.*, Rs. 10, 8, 6 and 5, and a fair proportion of each class should be distributed to each Division.

I know of one Division in the Punjab, in which there are no men on Rs. 8 or 10. Thus the guard, who has been promoted to Rs. 6, has probably got to the end of his tether, as inter-divisional exchanges can hardly be made for men of this class, and it is not likely that a man on Rs. 6 is fit to be promoted at one bound to a Forestership.

II. It should be a standing rule that no man unable to read and write the local vernacular* well, should be promoted to more than Rs. 6 per mensem, and only to that for long service, or other special qualification.

Security should be taken from all native subordinates. The 3 lower classes of guards should give Rs. 100 each; the Rs. 10 class Rs. 250; all Foresters, Rs. 500; and the Rangers one year's salary each.

All security bonds should be registered in a recognised registration office to ensure their being valid.

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* Urdu in Bengal Presidency, being the vernacular of the Court.

III. A Forest Ranger's duty, when not a definite charge, as a sale depôt or plantation, should be the supervision of two or more Foresters' circles, marking trees for felling, inspecting the Foresters' offices, seeing that the books and returns are properly kept up, moneys regularly paid into the Treasuries, &c.

The Forester is the person responsible for what occurs in his circle, which should, as far as possible, correspond with the Civil Tahsil. He should receive his orders direct from the Divisional Office, not through the Ranger, who can either have copies, or make himself acquainted with such orders by inspecting the Forester's office.

The Forester should receive the pay of the establishment under him, and be responsible for its distribution, see the felling and removal of the trees marked by the Ranger properly carried out, keep up whatever forms and registers are required, issue permits where necessary, collect revenue, report on all that takes place, and be responsible for the efficiency of the establishment under him: in short, the Forester is the chief executive officer in his circle.

To each Forester, I would attach a guard on Rs. 10 to be in charge of his office, his secretary virtually, to be always at the head-quarters of the circle. This arrangement provides for prompt replies to orders when the Forester is away in the forests, prevents the stoppage of such work during his absence, and also makes a sort of stepping stone from the guard to the Forester grade, enabling the former to become acquainted with the duties of the latter and so fit himself for promotion.

The guards on Rs. 8, 6 and 5 should have forest areas, not exceeding at the utmost 5,000 acres, apportioned out to them, the more difficult and important beat, of course, to the better paid. They should report themselves once a month to the Forester at his head-quarters and be responsible directly to him for everything occurring in their beats.

IV. The Forest Ranger should furnish weekly reports of his duties. For the Forester, monthly reports are sufficient, as every individual case is reported on separately.

The Forester's head-quarters being usually at a Tahsil town, for convenience of post, &c., pay is easily disbursed by having

letters of credit on each Tahsil. The Forester draws the cheque made in his name, and distributes the pay either during his tour, or when the guards report themselves at his office. The acquittance roll should always be sent in, duly signed, within a month of cashing the cheque.

In many divisions, the prosecution of forest offences forms a heavy duty: and this, I would entrust, as a rule, to Rangers, but when they are otherwise engaged, there is no objection to the Foresters, or in small cases, even the guard in charge of the Forester's office carrying out this duty.

Guards should not be allowed leave without providing substitutes. This is really no hardship to them, as they generally belong to the district in which they are employed and thus have friends or relatives who are willing to do the work for a month or so.

To Foresters and Rangers, I think, one month in a year may always be allowed, if necessary, without requiring a substitute, a small sum being deducted from the month's pay for the *locum tenens.*

The nature of the forest treated, the climate, and the circumstances in which officers of the Forest Department scattered throughout the length and breadth of India are placed, vary so greatly, that it is impossible to lay down in detail rules to suit every case, but general principles may, and should be defined. I, for one, shall be greatly obliged if other officers will publish the results of their experience.

Memorandum on Jungle Fires.

By M. J. Slym,

*Deputy Conservator of Forests, Salween Division, British Burma.**

1. There is a general belief among the majority of Forest Officers that these fires yearly do a great deal of harm to the teak producing parts of the forests, and considering what a number of seedlings must be either killed or injured by them

* We trust that the above memorandum will cause a vigorous discussion of the subject of fire protection.—The Editor.

annually, the current view would at first sight not appear to be entirely without grounds.

2. A great deal has been written both for and against these fires; many have pronounced their effects upon the forests to be unqualifiedly injurious; some even think that they must be prevented at any cost; while others believe that they act favourably towards the growth of the teak, and the Commissioners in Bengal are of opinion that these fires kill yearly a great number of injurious insects and their ovaries which adhere usually to fallen leaves, &c.

These views are naturally enough all based upon common sense, but the *pro* and *contra* are no where sufficiently elucidated. The first does not show how the fires could be suppressed without doing harm in some other direction, and the second does not disclose how they act favourably towards the growth of the teak; the Commissioners of Bengal mentioned only one important fact and overlooked all others, but of course it must be remembered that it is not the specialty of these gentlemen to investigate all the intricacies of such a subject.

3. Before entering into the bearings of this important question, I must first detail the causes from which the fires arise and at what time of the year they usually prevail.

The principal causes are :—

1. The firing of the Toung-yahs when high winds prevail.
2. The camp fires left burning by travellers.
3. The firing of the jungle for the purpose of driving out game.
4. The burning of the rubbish near the villages and gardens.
5. The burning of the forest near the villages to keep tigers and other wild animals at a distance or to frighten them away.
6. The cleaning of the roads and pathways by which people have to travel, which enables them to avoid snakes, &c.
7. The tradition of the hill people that burning of the forest has a salutary effect, kept alive by actual experience of the increased healthfulness of the districts after the fires.

8. In the higher regions of the hills, by the Karens travelling with torches during the night either when overtaken by darkness or to avoid the heat of the day.

9. Spontaneous combustion, a cause admitted by many, but which I have no reason to believe in.

4. It is hardly necessary to observe that the occurrence of fires is limited to the dry seasons, for they never occur during the monsoon. They usually begin in the month of February, at which time a great number of trees lose their leaves, but they are not violent before March or April, after the heat of the sun has dried the grasses and dead bamboos which are at other times saturated by the dew or rain.

5. It is no doubt easier to trace the course of mischief than to remedy it without at the same time doing harm in another direction. The first impulse has been to say "prevent the fires by keeping well-cleared paths round the forest tracts and have these watched during the dry season," but the question is, firstly,—Would this prevent them altogether over the whole of the teak producing parts of the country? Secondly,—What would be the cost of this fire tracing, as it is called, to the Forest Department? Thirdly,—What indirect effects have to be foreseen, which the change might bring about, and which might possibly lead to the development of a greater evil than the one to be obviated.

Fire tracing may be attended with success in some parts, but in some it will not; in others the object is at present partially attained without such expensive measures, for it must not be supposed that the whole of the forests is in a blaze every year; some parts burn regularly, but some are either free or slightly affected by fire for two or three years successively; and this explains why more trees are not injured, and how it is that we find such magnificent timber in the higher parts of our forests. Moreover, in as far as fires are due to the first cause, can they be prevented? Could Toung-yahs be interdicted? Never, for it is the custom and habit of the hill tribes, which must be allowed as long as they remain in existence and have to cultivate for their own support.

It is undoubtedly true that a path may be cleared around every *Yah*, so as, if possible, to prevent the fire spreading, and this may be serviceable when there is no wind, but usually in the month of March, or the time when these Yahs are fired, strong and high winds prevail which carry the fire great distances thereby igniting the dry leaves and grass. Could the guard at the outer fire-path of a tract to be preserved prevent the fire striking across? Single-handed, certainly not. If produced by cause No. 5, could it be expected that such a guard would be able to stop the progress of the fire? Could it be expected that he would remain day and night on his beat and that he should remain after sunset to be taken off by a tiger or other wild animal? The risk by day is already more than sufficient. The measure recommended for the keeping out of these fires may be successful with small forests like the Kalatop in India and in a tract without any main road or path-way, like the Sinsway in this Division, but I doubt their success with large and continuous forest like the Thoung-yeen, unless at a great cost to the State; moreover, it has never been tried yet, whether the measures recommended would answer with regard to the forests in these Provinces, for we are not dealing with pure teak localities but with jungles, which among other vegetation contain at the most 5 per cent. of teak only, amongst the different trees there aggregated, so that if the keeping out of these fires act beneficially towards the teak, it will also do the same for the preservation and re-production of the other kinds and produce a kind of struggle between the strongest and most *rapid in growth of tree vegetation.* Besides, it is a measure of which the good or the bad effects cannot speedily be perceived, for with every care, we shall hear now and then that some parts have been accidently fired, and this may give an opportunity to the old and usual springing up of teak seedlings in the burnt parts and so afford a confirmation one way or the other of the accuracy of the old or the new theory.

6. Before recommending such expenditure, we should have positive experience of the bad or *good effects of keeping these* fires out of the Burma forests.

The injuries done by these jungle fires are given as follows :—

1. They either partly or wholly kill the seedlings.

2. They burn and destroy the seed.

3. They char the outer bark of the young trees or saplings at their base, which part is in consequence liable to be attacked by insects.

4. They burn the humus and thus lead to the impoverishment of the soil.

7. The first reason is not groundless, for when the fire is violent, and creepers and rubbish surround the young trees, it often kills them partially or outright; they are then either lost or become worthless for the production of regularly shaped and sound timber; but, as I have already mentioned, it is questionable how far fires could be entirely prevented by the measures advocated. With regard to the second reason, I can only state that blackening or partial roasting of teak seed by a layer of leaves does not always destroy the inner kernel or germinating part of the seed, but as supposed by many, increases its germinating power and that the real destroyer of the seed is an insect which bores a minute hole into the shell and eats the inner part. This evil undoubtedly will also increase by the keeping out of the fires and allow the multiplying of the thousands of ovaries which otherwise would have been destroyed by the burning of the leaves to which they usually adhere. As to the third reason, it is a well-known fact that this is not the cause of the beetle holes found in timber. In full grown trees these beetle holes are found over the whole of the surface from its base to the top, and with regard to the Forest tracts in my Division, the wood of which is subject to this defect, I am in a position to controvert the argument, for I have seen many a good squares sawn from logs marked with beetle holes. This shows that they cannot have penetrated further into the tree than some 2 or 3 inches, and that it must have been attacked when of a large size. Again if the fires had anything to do with these defects in timber, why is it that certain tracts only produce timber with this defect and not the whole of the Division, it being understood that jungle fires rage in one part as much as in the other? Or why is it that timber from some parts of the Foreign States never show these defects, where jungle fires are unrestricted?

Moreover, charring is known to have a conservative effect and would prevent rather than encourage the attack of insects. I now approach the fourth and most important source of injury done by the jungle fires, one with which it is less easy to deal, presupposing as it does a *knowledge of the chemical changes which* fire produces in the organic and inorganic matter upon and in the Forest soil.

8. Before going into detail, I may draw attention to the simple practical lesson regarding the effects of the fires and the ashes produced by them upon the Forest soil with respect to Toung-yah cultivation. What would such ground produce when simply cleared, without being well fired and having a large quantity of ashes deposited upon it? It is by the agency of the latter that a good crop is ensured and should it happen that such *yah* caught fire before the intended time, when the debris is thoroughly dried, that is, if the ground has been inadequately broken by an insufficient heat and the unburnt part of the trees have supplied an insufficient quantity of ashes, the prospect of a crop is either wholly or partly lost.

9. It will not be out of the way to quote here a few lines of Dr. BRANDIS' Forest Report of Pegu for 1856 (page 154)— "We must, after describing the disadvantage of the Tough-yah "cultivation system, not omit to state that in some respects it "may also have its advantages. In the Prome District on dry "hills near the Northern Nawing, the burning of the trees "and shrubs for Toung-yahs cultivation does not create a mass "of low dense jungle as in other parts of the country. There, "*on the contrary, the fertilising* influence of the ashes has "another effect. An unusual abundance of young trees are "found on deserted Toung-yah, among which there is generally "a due proportion of teak." Dr. BRANDIS, of course, saw in the Nawing Forest old Toung-yahs which must have been at the least 12 years undisturbed, the others he saw in other parts and alluded to as dense low jungle, must have been three to six years only laying fallow—after twelve years in almost every instance a young *Forest has been created anew, and which, if* left undisturbed for about thirty years, will have entirely passed out of the condition of a Toung-yah poonsoh.

What holds good for the growth of paddy will, of course, hold equally so with regard to Forest trees; many a forester will have noticed the fine teak saplings which spring up from almost every burnt heap and near every burnt log of wood. This shows *clearly* that vegetation derives some benefit from these fires, nor must the beneficial effect they exercise upon human life be forgotten, one, which advocates of fire conservancy sometimes leave out of sight completely. Our Forest atmosphere *is charged with gaseous products of decomposition* injurious to the life of men and animals, by the increase of which the air would become infinitely more deadly.*

10. Our Forests are unhealthy, and it is an admitted fact that conflagrations alter the condition of the atmosphere and act beneficially by promoting the healthiness of the locality. They either drive the noxious air away or alter the condition of it. Even under present circumstances, heaps of rotten humus leaves and rubbish are found in the valleys or hollows of the hills, which have been driven down the slopes by the heavy rains and wind; this will be the same under the proposed system, for it is not correct to suppose that the fallen leaves and woody matter would then remain on the slopes of hills or high ground, for not only does the rubbish *wash away but also the soil itself.* During my four years' continued stay in the Forests, I have observed many a blown down large trees with barren rock below it, which shows that at the time the tree germinated this rock must have been covered by several feet of soil. More is accordingly gained by allowing the leaves to burn where they fell, for the ashes would fill up crevices caused by the heat and when the rain set in would be at once taken up by the soil.

The ashes of woody fibre are valuable as manure, for they return to the soil the mineral ingredients which were removed from it by vegetation and of which they form a part. Hence the

* In the air at home carbonic acid gas is found to the extend of $\frac{1}{1000}$ part only, but in Burma where rotten *leaves and vegetable matter* are *more* abundant and heat and light, the promoters of this gas in combination with the oxygen of the air, are much stronger, the quantity of this gas must already be under present circumstances twice what it is in Europe. However in that quantity it has hitherto only slightly affected in some instances the life of the people as the luxurious vegetation of this country acts favorably towards the absorption of it, but by increasing the present quantity, poisonous fevers and other kinds of epidemics will be sure to follow as a consequence.

burning of leaves, fallen trees and dead bamboos renders soil more fertile, for it not only furnishes a considerable amount of mineral manure in a *readily available form*, but it also assists materially in disintegrating the felspathic constituents of the soil which are then more *readily acted upon by air and moisture* after being thus exposed to a moderate ignition than when present in their natural condition (Toung-yah cultivation). It must also not be forgotten that as plants have no power of locomotion their food must be universally distributed and that this is more practicable with manure in form of ashes than otherwise, for it mixes sooner with the upper soil, whereas a heap of leaves may be driven into the hollows only.

It may be objected that by burning the dried leaves and wood the organic constituents disappear and the inorganic part or ash only is left. This is true, but the office of the former, *viz.*, of disintegrating the crude mineral constituents of the soil, is partially rendered unnecessary by the return to the ground of the mineral food of vegetation in a form admitting of direct absorption.

11. The chief benefit of keeping the leaves unburnt is to protect the upper soil from being exposed to the heat of the sun, thus keeping it moister than it otherwise would be; but the leaves of teak trees and many other kinds which fall during the months of March and April, are not well-suited for the purpose, nor are they also easily converted into mouldy manure (containing carbonic, humic, weak nitric and other acids): This too is such a tedious process extending over many years that in the meantime *it is almost certain to get* fired once.

12. Forest soil in Burma differs greatly from that in other parts of the world, which makes it highly important to first experience the possibility of carrying out the proposed alteration, and its effects, if found feasible, as well as to study the likelihood of possible encroachments of trees, forming Forest of a more moist type, upon the teak producing localities, before altering that which has proved sufficient for many centuries.

I may *here also note that in this Division the Mittegate* Kyouktaga Forest, formerly an extensive and most valuable teak tract, has been entirely transformed into evergreen Forest,

as it is called. A few large and very old teak trees are still standing, but nearly all the remaining are dead trees found lying in the grass and rubbish. This number of fallen trees is so great that several years' working has not been able to remove the same, and not a single middle-aged tree alive or dead or seedling is to be found anywhere. Other instances of this nature have been observed by Major SEATON in the Upper Thoung-yeen, near the Pawpee stream and elsewhere, and have been recorded in the Conservator of Forests' Report, for the year 1865-66 (page 5),—and the Inspector General of Forests, in his remarks on the Forest Report of 1864-65, wrote thus :— "This change is of no small importance considered as a question of Conservancy and of Finance, and it might be deemed "worthy of special and scientific investigation."

Time has taught us that it has become the more important as the present fire tracing arrangements are favorable towards the alteration of the Forest soil—by moisture or otherwise.

13. It must not be supposed that all the dead and injured trees found are due to these fires; I have found many injured by creepers and many dead seedlings, which were injured by a small beetle boring a minute hole into the stem, so as to get access to the pith of the tree, where it feeds and deposits its eggs. These insects would have also a better chance of multiplying than now. This shows that the opinion of the Commissioners in Bengal is not altogether groundless. The Inspector-General of Forests refers to these destroyers of Forest trees in his Circular No. 1, dated Simla, 23rd June 1866. The keeping out of the Forest fires would not remove these causes of destruction; and picture the evil that would ensue from the accidental ignition of several years accumulation of rubbish, a danger that will always be present so long as the material remains undestroyed as has now been shown by the Kyekpyoogan plantation. If a young seedling is destroyed by fire the first year, the next season a shoot usually springs up from the root, which in one rainy season is just as tall as the original tree would have been in two seasons if left undisturbed,—a fact also liable to be overlooked and which shows the effect of fire upon the growth of teak.

14. The collective inference I draw, is that these fires should not be prevented *entirely*, but the strength of them sufficiently lessened to lessen the harm. This can only be effected by firing the forest ourselves, two or three times during the dry weather, *commencing in the beginning of February, before the* leaves are so thick on the ground, as in burning to cause an injurious heat to the trees; while in each interval the quantity collected would be insufficient to cause any harm. Those engaged in firing the Forest could clear the young and old trees from creepers or any vegetation endangering their growth.* I would also recommend the burning of all dead bamboo tracts, and afterwards casting over the surface a large quantity of teak seed; the bamboo may spring up again, but the kind we find on the hills, usually grows in clusters with sufficient room between them to allow the growth of teak saplings. If these belts of dead bamboo with which our Forests are periodically intersected are left unburnt, millions of the seed germinate which otherwise would have been destroyed, and the country becomes such a wilderness there is no chance left whatsoever for the springing up of a teak seedling amongst the bamboo, besides the ground being covered by rubbish and the teak seed being large, the latter remains on the top of it to rot, and the smaller kinds of seed which penetrate this rubbish and come in contact with the ground have a better chance to germinate. It is perhaps this process to which Colonel PEARSON alludes at page 405, of the "Indian Forester" for April last:—"In the Boree Forest of the Central Provinces, where fires have been put out for many years, *it has been found that at least one* hundred seedlings of the Dalbergia and Pentaptera spring up for every one of teak."

The measures recommended by me for lessening the injurious effects of the jungle fires, if kept up for about three seasons, would give certain results and prevent the damage done by excessive heat, but the present system is all but impracticable, and at best dangerous as it may, as already shown in the few

* These creepers constitute two of the greatest causes of inferior and irregularly shaped timber, as they kill the leaders of the seedlings and saplings, while the rubbish and dead leaves adhering to them, also break the seedling in two and give rise to forked stems.

lines quoted from Colonel PEARSON's article, drive the teak out of the enclosed parts altogether. It is of course fortunate for the existence of the teak and the interest of Government, that notwithstanding any expense and care these fires will occur now and then except in small and compact tracts.

15. The only certain way for the Government to secure a supply of valuable teak is by the making of plantations on a large scale; with these the Government will know what it has for its money, and out of such plantations the fires can be kept with very little cost, and with definite certainty, and there will be no interference with the custom and habits of our hill populations.

*** This memorandum was written by me some time back, and read at the Rangoon Forest Conference in 1875; but, I was there informed by the President that it could not be recorded, neither could the reason for doing so be mentioned, although it appeared to be generally admitted as worthy of consideration.—M. J. S.

Lac: Production, Manufacture and Trade.

By J. E. O'Connor.

The present is a revised edition of an interesting pamphlet published by the writer about two years since. It contains much new information, and a set of carefully prepared tables in connection with the trade in shell-lac and lac-dye, which were not available when the first edition was written, and the memorandum may now be said to record nearly everything of useful importance relating to the subject in question.

The production of lac, when carried on artificially, appears to be a simple undertaking, and to be conducted in much the same way in different Provinces. Briefly, the method practised is that of applying a few twigs or branches, on which lac encrustations or cells have been deposited by the "Coccus Lacca," to the new trees desired to be brought under cultivation, care being taken that the trees so treated belong to one of the many species for which the insect has a proclivity, and that the seed-lac is applied to them at the proper season. Mr. O'Connor gives us separate descriptive accounts of how the above process is carried out in several different parts of the country, and we believe we are correct in stating in a general way, that all the raw material has up to the present time been collected or produced by private individuals.

From a table published on page 39, we learn that the foreign trade in shell-lac, the manufactured article, has developed very rapidly during the last ten years, increasing from 36,653 cwts., the quantity exported in 1866-67, to 80,645 cwts. in 1875-76; and that within nearly the same period the market price of the article has fluctuated in an extraordinary manner. In 1865, a maund, weighing 82 pounds, of fine orange shell-lac realised Rs. 30, which price fell to Rs. 24 in 1867, rose rapidly to Rs. 94 in 1874, and fell again to Rs. 51 during the early part of 1876. This fall in prices appears mainly to have arisen from the market becoming temporarily overstocked, the result of a rush to supply an article for which there was a brisk demand and in which rapid and large returns were obtained,—to competition, arising from the establishment of new firms, and also partly to the inferior article presented for sale. During the year 1875-76 there appears to have been an increase in the exports of 13,000 cwts., and it is said that this increased demand, coupled with the previous high prices, encouraged adulteration to such an extent, that the so called lac, in many cases, consisted of 50 or 60 per cent. of ordinary resin. On this subject the writer has the following :—"The effect of the great demand for shell-lac and the excessive speculation in the article during the last two years are shewn in the figures representing the exports for the official year 1875-76. Since then, however, there has been a

corresponding reaction and depression in the trade, and prices have fallen, as will be seen from the table printed on page 55, from a maximum of Rs. 97 a maund and a minimum of Rs. 53 per maund in 1874, to a maximum of Rs. 57 and a minimum of Rs. 22 per maund in 1876. It is not probable that this depression will be of long continuance; but those who are interested in the trade might do well to take warning by the fall which has occurred, and bear in mind not only that it is possible to overstock the market in a period of feverish excitement, but that unreasonable prices may cause consumers to turn to other sources of supply than India for their lac. It is an error to suppose that India alone produces lac. No doubt, practically she may be said to possess the monopoly of the trade at present, but some quantities are also exported from Siam and the Straits Settlements, and a development in the trade of these countries would assuredly follow upon a continued unreasonable valuation of the Indian lac, and carelessness in its preparation for the market. A considerable silk trade has gradually slipped out of our hands, and a once flourishing industry is in a state of decay, because unreasonably high prices have persistently been combined with an inferior article."

We however are not sanguine that the rates of shell-lac will rise again to any material extent, unless the industry should receive a still greater impetus than heretofore by the commodity coming into more universal requisition; or that the firms who have lately engaged in the trade, on the expectation of realising the prices of 1874, should back out of it on finding that this is not probable. The former high prices, we believe, were greatly owing to the limited number of European houses engaged in supplying the foreign markets, who as long as the demand continued in excess of, or equal to, the supply, could obtain, within a certain margin, whatever prices they chose to impose. Since then, however, the trade has developed, new factories, belonging to new men, have sprung up, and the industry has been commenced successfully in other countries than India; and it seems to us that this competition may fairly be expected to have a lowering effect on the pulses of the market, especially as it would appear that the demand

has attained its present limit. But from a return given on page 41 of the pamphlet we learn that more than 90 per cent. of the total amount of shell-lac exported from British India is shipped at Calcutta, and that about the same proportion of the whole is purchased in unequal shares by Great Britain and America; the former taking 59,199 cwts. out of the total quantity sent to these two countries, *viz.*, 72,814 cwts. There are good grounds, therefore, for hoping that, should no better or cheaper substitute be discovered, the present demand may hereafter expand to a considerable extent. The amount of stick-lac sent out of the country appears to be quite inconsiderable.

Compared with shell-lac, the trade in lac-dye has undergone even greater fluctuations. The quantities of this article exported rose from 11,700 cwts. in 1866-67 to 20,500 cwts. in 1869-70, from which date there was a rapid fall to 8,377 cwts. in 1874-75. In the following year, however, there appears to have been a slight reaction in its favor, as the exports rose to 10,592 cwts. Lac-dye has fallen too in price to such an extent, that one is led to wonder how it can pay the manufacturer to give it any attention, or to indulge in a calculation of the profits that must have been realised from its sale a few years since: if a decent return can be obtained from selling it at Rs. 15 per maund—its present price—what could have competed with it as a fortune-maker when it was selling at Rs. 85 per maund in 1869. But its day seems to have passed, in spite of its having been removed from the list of dutiable exports. "Lac-dye, in fact, is now of very minor importance, both in the eyes of manufacturers and shippers, as compared with shell-lac. It has always had competitors in cochineal and other dyes, but lately the competition of mineral dyes has become very formidable. These aniline dyes are produced so cheaply, and are worked so easily, that they threaten to supersede the use of most vegetable dyes, and it is probable that the prospect of Indian dyes will before long require much consideration from the State and all interested in them." With regard to cochineal, we have seen it stated that the Canary Islands and Madeira turned out between them the large quantity of three million pounds weight, and that Great Britain alone paid annually a million

of dollars for the dried bodies of the insect containing this dye.

Mr. O'Connor mentions that the Forest Department has commenced the artificial production of lac in at least two different Provinces, but we are not informed to what extent their efforts have succeeded, beyond the fact that a few acres of lac plantation have been established with good results in Burmah. One point appears tolerably plain, *viz.*, that the manufacturer has up to the present time found no difficulty in obtaining the raw material in sufficient quantities, and at a rate to enable him to turn out the worked-up material with handsome profits; for his prices, as we have seen, have suffered from the markets becoming overstocked. Under these circumstances it becomes a question whether Government should take part in the production, and unless good reasons can be shewn for the step, it would appear to us inexpedient. But there can be little doubt that Government should be able to carry on the cultivation in a cheaper manner and with less risk than can be done by private individuals, for the production of lac is more or less a speculative undertaking. A drought will render unproductive two or three seasons' work, and in Indian Forests the same result may be brought about by fires, which are an annual institution over the greater part of the country where the insect is found. Frost, too, has a very damaging effect on the crop, and the winter gathering may be badly effected by heavy rains during the summer evolution of larvæ. Of course, the risk from physical causes, such as drought, frost, and rain, apply equally to both Forest Department and private speculator; but the former have large areas of forest which are protected from fire, a trained and intelligent staff of officers and subordinates, and extensive tracts of forest land from which suitable selections could be made, all of which appear to us facilities likely to render their efforts more uniformly successful than those of private agencies; and if so, they merely should result in the production of the article at a minimum expense. For these reasons we hope the Department will give the experiments their best attention, and not allow one or two initial failures, should such be

experienced, to lessen their endeavours in bringing this means of increasing the forest surplus to a successful issue.*

Z.

III. Notes and Queries.

Forest Management in Madras.*

No. 17. *Read the following letter from Lieutenant-Colonel* H. R. MORGAN, *Officiating Conservator of Forests, to the Secretary to Government, Revenue Department, Fort St. George, dated Ootacamund,* 12*th August* 1872, *No.* 1415 :—

WITH reference to Campbell Walker's report on English and Scotch Forests I have the honor to forward a Memorandum on the subject as certain suggestions regarding Reserves are made which, in my opinion, might with advantage be carried out.

ENCLOSURE No. 1.

Memorandum on Captain Campbell Walker's Report.

RESERVES.—The most important part of the report relates to the fresh light thrown upon the communal rights of those living in the new forests and the action of Government regarding those rights. It will probably be found that some similar action on the part of Government in this country would work well. For instance, where it is desired to improve a rich part of a forest, this part, to the extent of one or even ten square miles, might be fenced in and planted up, and at the end of twenty years, when the trees were well grown, might be thrown open. In this manner considerable areas of forests might be successively taken up without at all interfering with grazing or other rights.

2. PLANTATIONS.—At page 10 it is admitted by one authority that pits are better than mere "slits" even in England, and I am very sure that pits are far superior to mere "slits" for India. The cost of pitting seems much the same in both countries; but everything depends on the soil—the richer and

* We have been requested to publish these papers, which are supposed to show that the doubts, entertained in the October number of the "Indian Forester" regarding the practice of forestry on the Madras side, are unfounded.—THE EDITOR.

looser the soil the smaller the pit, the harder and poorer the soil the larger the pit. There is a third reason why deep pits are desirable in this country, *viz.*, that the roots may rapidly bury themselves in the moist sub-soil below the influence of the sun's rays. Our pits in dry places are often two feet deep.

At page 17 Captain Campbell Walker in the last paragraph suggests the English mode of treating nurseries. From my experience I may say that it would not do. Did we grow firs and other trees which at five years of age are only six feet in height it might be practicable? but the trees we principally plant, *viz.*, teak, eucalypti, and casuarina grow six feet in a year and must be put out when young. As for the cutting of the tap roots I may say, as a rule, they are always shortened, and I do not understand how the mistake arose on Captain Walker's part. No two trees are treated exactly alike; but I may, to prevent future errors on this head, explain the system.

At Nellumboor the seed is sown in beds in April. These beds are raised six inches and have an inner edge of three inches which retains the water for some time, when it slowly percolates through the bed. The seed is literally soaked in these beds for fifteen days; when it sprouts the supply of water is decreased. By the end of June the plants are six inches high. They are taken up, and have the appearance of a bundle of radishes. A man shortens the tap roots to four inches; if left longer the coolies turn up the end of the root, and the plant is sure to be sickly. At Mudumallai, which is much colder, our plants by July are only two inches high, with tap roots only three inches long; these are never cut, but carefully preserved. So it is with sandal-wood plants: we lift them when only three inches high, and never cut the tap root unless it exceeds six inches. With eucalypti the plan is to lift the plants when six inches high, cut the tap roots, and put them back into beds six inches apart: when two to three feet high they are taken up, their roots bound up with moss, and re-placed in beds. When the roots show through the moss the plants are put out in the pits. The failures from this mode of treatment are never three per cent.

I may mention that the tamarind and mango, when their tops are but three inches in height, have tap roots more than a yard long; it is best to plant these seeds *in situ.*

In a moist damp climate like England or Scotland planting out can be carried on for nine months in the year; in this country we can rarely plant out for more than two months. In fact, the general conditions of forestry are so dissimilar that what does well at home is very unlikely to succeed in India.

3. WORKING OF FORESTS.—At page 19 the stamping of trees is dwelt upon. This is practised on the Annamallies, where the trees contain from fifty to two hundred cubic feet. It will be found difficult to carry it out in all our forests; for instance Wynaad, which has had seven officers in ten years. This perpetual change renders forestry in this country very difficult; in fact, what with fever, impenetrable grass, constant change of subordinates, &c., we cannot afford more than the roughest kind of supervision; anything else will infallibly break down. In England they have no such grass, no fever, no impediments of any kind, and forestry, instead of being a life of great risk and exposure, is the healthiest life a man can live.

4. FENCING, as proposed at page 21, would cost double in India or ten annas a yard, and creosoting would hardly be effective against white-ants. A ditch and thorn hedge in out-of-the-way places would be found cheaper in the long run; but a small area might, as an experiment, be tried on the plan recomended.

5. ADMIRALTY TIMBER.—As we very probably shall no *longer supply the Bombay dockyards, the suggestion of sup*plying the English dockyards direct is a good one.

6. SAW MILLS.—What we require is a portable machine that can be carried to a depôt in the forest and worked by elephants or bullock-power, a single vertical saw. To saw teak and saw deal are very different things. I gave the idea of what was required to Mr. Smith, the Mechanical Engineer at Wellington. He promised on going home to see if he could work it out, but I have not heard from him. Many of our logs are so large that they require to be divided before they can be carted away. I have always experienced great difficulty

in obtaining sawyers for this work. What with jungle fever and the fear of wild elephants, my sawyers soon dwindled away, leaving the work unfinished.

Turbines when there is a fall are very effective, but circular saws are constantly buckling, and cannot be repaired except at Madras.

7. Grazing.—The remarks on grazing at page 23 are to the point and command attention.

8. Creosoting.—This was tried on the Madras line, but was not proof against white-ants, I believe.

9. In conclusion, I would remark that if an intelligent officer like Captain Campbell Walker had had opportunities of visiting Nellumboor, the Annamallies, Wynaad, &c., he would not have fallen into the errors regarding planting that he has done, nor would he have recommended (page 32) wire fences for places where elephants and bison, to say nothing of white-ants, would soon destroy them, nor (page 33) steam engines for forests where jungle fever would quickly prostrate the Engineer. I would only too gladly recommend Captain Campbell Walker's scheme if I thought it would succeed; but on the Annamallies and in Wynaad I fear nothing but the simplest sawing machine such as I desire, but cannot obtain, would be of service. It is admitted at page 32 that the sawing difficulties are "very great." The mode of felling adopted in Tinnevelly, cited as an example of "what now goes on," is an exceptional case, and hardly an example of what is done in the Department. Captain Campbell Walker deserves credit for ventilating these matters; but it seems to me that if we had a Manual showing the correct mode of sowing, planting, felling, dragging, carting and general mode of working the different forests, much misconception would be avoided and good results follow. Our present Manual is rather old, and was drawn up by various officers, some quite new to their duties. I would propose, if the Government consider it advisable, that a Manual for Forest Officers be drawn up by the Head of the Department; of course, in consultation with Forest Officers. The Manual might contain the rules of the Department, the mode of working different forests, the mode of planting pursued to be

exemplified by rough sketches, the cost of carting, felling, dragging, &c.

(Sd.) H. R. MORGAN, *Lieut.-Col.*,
Officiating Conservator of Forests.

OOTACAMUND, 12*th August* 1872.

No. 18. ORDER THEREON, 5*th September* 1872, *No.* 1280.

ORDERED to be communicated to the Board of Revenue for circulation to Collectors and their Forest subordinates.

Forests, No. 1.

2. The question of employing sawing machinery in the larger forests is one to which the Conservator should give his attention in communication with the Superintendent of the Government Workshops.

3. The Government fully approve the suggested compilation of a revised Manual, and request Colonel Morgan to draw Major Beddome's attention to the subject on his return from leave. Colonel Morgan is thanked for his Memorandum.

(True Extract.)

(Sd.) W. HUDLESTON,
Secretary to Government.

THE

INDIAN FORESTER.

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A Study on the Reboisement of Denuded Slopes and the Preventative Treatment of Torrent Areas.

Being a Review of Dr. J. Croumbie Brown's "*Reboisement in France.*[*]

In a literary point of view, Dr. Brown's book leaves much to be desired. With indefatigable industry he has acquired a vast mass of materials, and having divided them into four parts, like four great heaps, he presents them in bulk to the reader's mental digestion. Endless repetition of subjects, examples quoted over and over again, part of a subject dealt with in one place and the rest in another, are the natural results. If a descriptive motto for the book were required, it would be aptly found in the words "*Rudis indigestaque moles.*" Besides this, the style is discursive and the translation from the French singularly barbarous.

Take the following specimens, not necessarily the worst, selected at a cursory glance through the book :—

"One may affirm with certainty that if a remedy be not speedily applied, ere long the population will go on diminishing * * * I do not know if I deceive myself, but I believe it is possible to apply the remedy and I believe, moreover, that it is high time to set about this" (*p.* 10.)

"The torrents becoming more and more devastators of the country, in consequence of the destruction of these, will bury under their deposits extensive grounds which, &c. *(id.)*

"All the inhabitants have had was the delight to reap for some years a little barley ; to-day they no longer reap anything ; and they find themselves in misery" (*p.* 281.)

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[*] London, H. S. King & Co., 1876, 1 vol.

"The flood swept away the rocks with so much greater ease that nothing had been repaired since the first storm which left the stones dug out" *(p. 92.)*

"There was seen coming down in that of Yeuse, a small fillet of clear water" *(id.)*

"But every time this shall occur, you shall refer to the Administration who will address to you timeously the instructions, &c." (*p.* 168.)

"The inhabitants of the mountain, chiefly pre-occupied with the interest of pasturage, do not welcome in general, but with a certain apprehension, any measures relating to reboisement" (*p.* 171).

"The trees may touch when they have attained the state of perches" (*p.* 252). This, I suppose, is a translation of "*perchis*" (!) Again (*p.* 151) he speaks of the young 'fellings' being out of danger—meaning, I suppose, young thickets (*taillis*)! and in another place of *gemmaze* (tapping for resin) as "budding."

"The collet of the root is buried, &c." (*p.* 251).

"This department will be deleted from the map of France" (*p.* 282).

At page 300, we read of the 'insuccess' of planting works.

Some of these specimens of English could not be surpassed even by a B.A. of the Calcutta University. Many more might be given, but these will suffice.

Having said so much I gladly turn to notice the real merits of the work and the solid benefit conferred by the author on English-speaking foresters. *It is impossible, however, not to* notice these defects, because they make the author difficult to follow and require no little labor on the student's part to connect the mass of facts presented to his notice into a progressive chain, leading to definite and practical conclusions.

From a sense of the value of the materials, I have endeavoured not merely to review the book, but to write a study on it, and to put together and arrange the chief materials in such a way as to render the subject intelligible. For all details in further elucidation of special points the book itself must be consulted.

To reduce the study to readable limits, I shall assume in the first place that the mischief done by the denudation *of mountains* is very great, even in the first stages; much more so when real torrents have been developed. I shall further take it as well established that torrents, deep ravines, and landslips, at any rate, in a majority of cases, are caused or enormously augmented by the denudation of hill-sides of their trees and other vegetable covering.

I shall omit with some regret, the detail of those interesting but terrible recitals (which read like tragedies if their reality were not only too well established) which Dr. C. Brown *cites* in abundance as illustrating and enabling us to realise the destructive action of torrents. The history of the Devoluy district(1) of the torrents around Embrun,(2) of Combe d'Yeuse,(3) of Vacherès,(4) of St. Marthe,(5) of the Mella,(6) of the Ardèche, (7) and the St. Antoine torrent in the Bourg d'Oisans arrondissement(8) are of this nature. Some of them shew how successful well-directed efforts of reboisement may be. The history of the extinction of the torrent of St. Marthe by reboisement will deserve special attention, among several similar instances quoted in the later parts of the book (see *p.* 257, chap. V, and especially the cases on *p.* 172).

In the present study I propose to confine myself to considering and gathering together the practical information scattered here and there through Dr. Brown's book on the following points :—

1. The nature and peculiarities of torrents and their action: other phenomena of denuded mountains, landslips, ravines, &c.

2. The question how far forest growth either of trees, bushes, or herbage and grass is effectual as a protective agency, and as a remedy for mischief already done.

3. The procedure to be practically followed in dealing with slopes to be reboised.

SEC. I.—THE NATURE OF TORRENTS AND THEIR ACTION.

Dr. Brown's remarks on this subject are derived almost

(1.) Page 1.
(2.) Page 36 and page 32.
(3.) Page 91.
(4.) Pages 42 to 249.
(5.) Pages 259 to 264.
(6.) Page 12.
(7.) Page 276.
(8.) Page 208.

entirely from Surell's well-known work on the Torrents of the High Alps.

As natural laws are the same all over the globe, the intelligent observer will find Surell's laws of torrents very instructive in studying the subject in India. Indeed there is no branch of forestry, it may be stated at the outset, in which principles learned in Europe may be more fully applied to India, than that of torrent action and its remedy. In India, indeed, the power of vegetation is very much greater than in the Alps; while the power of herbage only, to retain the soil and the ease with which the unstable banks of ravines clothe themselves with vegetation as soon as a chance is given them, are elements which make our position very favorable.

On the other hand it is not to be supposed that our tropical or sub-tropical vegetation is able to stand *anything* that man chooses to impose upon it. Even in the hills below Darjeeling the effects of denudation are very marked, not less so than in the drier portions of the N. W. Himalaya. The following graphic picture of the county near Embrun, will not be without its parallel in many of our hill districts :—

"The clear, brilliant, Alpine sky of Embrun of Gap, of Barcelonette and of Digue, which for months is without a cloud, produces droughts, interrupted only by diluvial rains like those of the tropics. The abuse of the right of pasturage and the felling of the woods have stripped the soil of all its grass and all its trees, and the scorching sun bakes it to the consistency of porphyry. When moistened by the rain, as it has neither support nor cohesion, it rolls down to the valleys, sometimes in floods resembling black, yellow, or reddish lava, sometimes in streams of pebbles, and even huge blocks of stone, which pour down with a frightful roar, and in their swift course exhibit the most convulsive movements. If you overlook from an eminence one of these landscapes, furrowed with so many ravines, it presents only images of desolation and of death. Vast deposits of flinty pebbles, many feet in thickness, which have rolled down and spread far over the plain, surround large trees, bury even their tops and rise above them, leaving to the husbandman no longer a ray of hope. One can imagine no

sadder spectacle than the deep fissures in the flanks of the mountains, which seem to have burst forth in eruption to cover the plains with their ruins. These gorges, under the influence of the sun which cracks and shivers to fragments the very rocks, and of the rain which sweeps them down, penetrate deeper and deeper into the heart of the mountain, while the beds of the torrents issuing from them are sometimes raised several feet in a single year, by the débris, so that that they reach the level of the bridges, which, of course, are then carried off. The torrent beds are recognised at a great distance, as they issue from the mountains, and they spread themselves over the low grounds in fan-shaped expansions, like a mantle of stone, sometimes ten thousand feet wide, rising high at the centre, and curving towards the circumference till their lower edges meet the plain."

But to return; M. Surell draws a primary distinction between rivers, torrential rivers and torrents, which it is important to maintain. For the definition of a river is not necessary to enter into particulars; a torrential river is a river which has some of the characters of a torrent, but not all. It is common to speak of some of our hill streams, like the upper part of the Ravi, Bias, &c., as "torrents"; but this is incorrect, their fall does not exceed six in the hundred, nor do they exhibit the peculiarities presently to be noted. A torrent may flow into a river and impart to a part of the course of the river some of its characteristics. Thus, for instance, the Haro river, or the Soháu or the Bhimbar in the N. W. Punjab, are torrential rivers, largely affected by the numerous true torrents that join them.

A true torrent has, in the first place, rarely more than a slender thread of water perennially flowing: usually it is dry, except during flood seasons. It has a fall which may be two in the hundred down to six in the hundred, but not less. It consists of three parts: (1) the funnel-shaped "basin" (*bassin de reception*); (2) the gorge or "channel" which is permanent and may be of considerable length, or of unappreciable length, as will be presently explained (*canal d'ecooulement*); (3) the fan-shaped bed of deposit, which is formed (and is ever spreading

out while the torrent continues its baneful activity) of the detritus brought down by the torrent *(lit de déjection)*. I shall speak of these three parts briefly in English as,—"torrent-basin," "torrent-channel," and "torrent-deposit." For a particularly vivid description of the torrents enabling one to realise these definitions, see page 263-4 of Dr. Brown's book.

M. Surell again classifies torrents into three kinds. And these distinctions explain further the different portions of the torrent we have been speaking of. The *first* occurs where the torrent starts from a "col" a neck, or pass at the head of a valley; here the torrent occupies the angle between the mountains forming the valley. In this case the "basin" may be every extensive, and, in fact, may be supplied by a great number of small streams and smaller torrents converging to one point, the apex of the funnel of the main torrent; here too the channel may be of some length according to the steepness of the incline before the bed of detritus at the junction with the valley is reached.

The *second* class contains those torrents which arise from an amphitheatre or hollow at the top of a mountain and flow down the line of greatest declivity: here the basin may be rather extensive, but the channel is sure to be shorter than in the first class.

The *third* class of torrents arise from a depression, hollow, or morass at some point on the flank of a mountain. These we may commonly see in the Himalayas, but in them the channel is very short or altogether wanting, for the apex of the funnel is continued almost up to the apex of the fan-shaped "deposit."

The funnel-shaped basin, in all cases in which a torrent is in activity, is perpetually enlarging as the sides fall in and ravines form, and from it is derived the mass of materials that goes to increase the spread of the deposit. The "channel" where it exists is that portion when there is no more falling in, and the torrent is restrained by strong banks. What looks like a channel at first may often prove only to be a prolonged apex of the basin, as it is always falling in and widening, and more perfectly forming the funnel shape of the "basin."

Sometimes a torrent exhausts itself. When the funnel has

fallen in and worn away till a stable angle is reached, and there is nothing more to wash away, the action becomes less violent, because only clear water can come down. And it is to be recollected that the destructive action of torrents is not merely due to a rush of water as water, but of water the laws of the flow of which are modified, and its weight, resistance, and friction enormously increased, by being in a more or less viscid state, through the quantity of soil, gravel, and stones, held in suspension. Directly, either from natural causes of exhaustion, or by some agency which prevents the washing away of more material, the water holds little or none of such substances in suspension, its violent action is reduced and it returns to the laws of fluidity. We must not wait to see torrents fully formed in all cases, but be on the constant watch to interfere *at the commencement* of the evil. A natural depression in which snow can lodge, or a landslip often give rise to torrents. First ravines are formed, then these unite, and so the funnel or "basin" of a veritable torrent is completed.

A remarkable feature has to be prominently brought to notice with regard to the torrent deposits. While a section of an ordinary stream would show a curve concave towards the sky, the lower part being water, and the higher the banks on each side, the torrent deposit is converse, and the water flows in a slight depression on the highest part of it. Directly, therefore, the water increases, it overflows and spreads out, forming innumerable streamlets all over the deposit, and continually altering its position: but the process of formation always goes on in the *same way, and the tendency to form a fan-shaped convex mass* is kept up by fresh additions of detritus.

I cannot devote any space to a consideration of the natural history of torrents. Much interesting matter may be gathered from Sec. II, Part I of Dr. Brown's book (*p.* 30), the effect of climate, geological formation, and so forth are there discussed. A torrent will be formed in time whenever the soil is ready to give way, and then it wants only the first start, usually given by denudation, but occasionally by a landslip or stone slip which creates a hollow in the hill side. The hygrometric condition of the air, and the fact that a moist atmosphere promotes vegetation,

makes a vast difference in the facility with which torrents are formed; for a soil in a dry air, with occasional and violent rain will be cut up with ravines, while a similar soil always in mist and subject to drizzling rain, will not.

We have not to wait until what I may call a formal or fully-developed torrent is established: we have on the contrary to begin in time, nip evil in the bud, and to arrest all sorts of ravines and cuttings, and to reclothe the barren slopes at the outset.

Directly, a hill side is denuded, the soil will begin to disappear, deep rifts or furrows will begin to form, then veritable ravines, and these will all be so many secondary torrents or feeders of a main torrent. Landslips will become common, springs will dry up, and streams which might otherwise be perennial will remain as dry and stony beds only full of thick muddy water, but rushing with destructive force during the rainy season. It is not on every soil that torrents will form, nevertheless fertile soil will be washed away, and the ground will be cut up, crevices, rifts and small ravines will form as may be seen in the Jura and at Karst in Illyria.*

To sum up shortly, we may either have regular torrents, or we may have denudation and defertilization of soil, the formation of rifts, ravines, crevices, and landslips.

Torrents are distinguished by their flowing only with occasional violence, and above all by the fact that in them the violent flow is (1) periodical, and (2) not only subject to the hydraulic laws of limpid water in motion, but to a supersession of such laws and their replacement by the laws of thickened or viscid fluid owing to the water being full of mud and gravel held in suspension, and therefore capable of producing different results as regards erosion and subsequent deposit of material.

Section II.—How far Forest Growth is Effective in preserving Soil and preventing Torrents.

It is hardly necessary to do more than point out that forest growth first breaks the violent force of the rainfall, causing a large proportion of the water to be for a time retained on

* See p. 96, "Reboisement in France."

branches, leaves, and stems; thence to be slowly discharged on to the ground, or returned to the air by evaporation. Secondly, that the product of forest growth is a mass of dead leaves, mosses, &c., of immense hygroscopicity and capable of absorbing a vast volume of water, and slowly distributing it to the sub-soil and to the roots of the trees and smaller plants, while the surplus runs off in a gentle stream and quite clear.

Vegetation also binds the soil by pushing out thousands of interlacing rootlets; and this is the reason why, if vegetation is given a good chance by the exclusion of cattle and fires, ravines and incipient landslips and stone-falls can be checked at an early stage, when the soil is still capable of affording nourishment to *some* herbage, however coarse and apparently insignificant.

The action of the vegetable growth is also to *divide* the action of the water, so as to prevent a number of streamlets readily uniting in one line of flow, and thus bringing a combined force and volume to bear on the excavation of a channel or ravine.

I may further confirm these views by a quotation from one of the authors noted by Dr. Brown. I refer to C. DE BASTELICA:—

"If we could expose by a vertical section, a wooded slope, it would show in the upper portion a layer of varying thickness, but most frequently of from 30 to 40 centimetres (12 or 15 inches) of *humus* in which the fibrous rootlets are so developed that the whole has the appearance of a woolly material. This layer is at once a sponge and a filter. The large roots of the trees penetrate more or less into the subjacent rock.

"When the rain falls on ground covered with wood, a considerable portion of the water is restored to the atmosphere by evaporation; another portion is absorbed by the immense expansion of foliage and boughs. If the rain be prolonged, the water comes at length to the ground, which again is capable of absorbing an immense quantity. A flow from this is slow to establish itself; it is necessary first that the saturation of the sponge-like layer be complete; and when this is effected, when the water has been able to make a passage

for itself by an infinite number of imperceptible channels, the flow like that of a charged syphon maintains a certain uniformity of flow, and this it continues for a long time after the rain has ceased.

"So much is this the case that opponents have alleged that forests are more hurtful than beneficial, as they tend to prolong floods. The flood is prolonged it is true, but the delivery is regulated, *diminished at the commencement, and increased at the close*: the total quantity of water drained away takes a longer time to flow; it flows during the whole of that longer time; and what is of more importance, it flows uniformly and equally, with no sudden variations, and thereby much evil is avoided; and, what is of more importance still, the forest acts at the same time as a filter, delivers no water, but what is of perfect fluidity, scarcely even discoloured by the washing away of organic matter, and unable to wash away the earth of the sub-soil protected against erosion by its thick covering of *humus*.

"When, on the contrary, the rain falls *on a soil stripped of* vegetation, it tends to cut this up into ravines, and it does so if the tenacity and resistance of the ground be not sufficient to withstand it; and the flood *is subject to great variations in* its current, carrying off here and there the earth and other *dèbris* of the soil.

"Forests have then a double action; on the one hand they consolidate the soil, on the other hand they reduce and regulate the flow of the current, acting at once both on the delivery *and on the perturbation,—in other words, on the primary* cause and on the secondary causes of the overflowing of water-courses."*

We must be careful, however, not to push the argument from the value of vegetation too far, and thus lead those persons who are still inclined to dispute the *whole question, to* reproach us with an exaggerated confidence in natural agencies. It is perfectly true that there are cases of landslips, and falls of rock masses which no forest growth can prevent. It is

* R. in F., p. 110.

also true that the very power of retaining water may, in some cases, increase the weight of a bed of mobile soil, resting on a highly inclined solid stratum of rock and so promote its fall. This is especially the case when a road cutting on some part of a steep hill side has truncated the slope, and thus given the mass above an open way to slip down.*

But the cases in which forest by absorbing moisture causes this evil can only occur exceptionally where there is a peculiar combination of natural circumstances. And it is certain that for every case where they do combine, and a landslip results, there are hundreds in which the preservation of the forest has saved the whole hill side from destruction by erosion and ravining. Moreover, in cases where the evil spoken of is threatened, it is often possible to foresee and prevent the slip by proper draining. But, under any circumstances, the fact that failures may occur should not debar us from the only known efficacious remedy. We do not (as was remarked once before in this journal) refuse to call in medical aid, because doctors occasionally fail to cure diseases. Moreover, it is to be recollected, that when landslips occur in exceptional cases, they do not repeat themselves, whereas in other normal cases, the evil goes on extending, from one ravine† to many, from the little gutter that first trickles and runs over the hill-side, to the roaring cataract, whose eroded sides continually fall in.

One other point may be noticed in connection will this subject, and that is this one which Engineers should take to heart. The value of vegetation in *aiding* engineering works *is quite beyond dispute.*

At Simla some of the worst cases of ravining (*e. g.* the great ravine beyond the "Lakri Bazar)" have been met by making a channel for the water of boards: but the consolidation of the sides of the hill, and the fixing of the water channels, so as to prevent the costly necessity of renewing the woodwork, could be completely secured by at once staking the soil

* See p. 248. R. in F. where some striking examples are given.

† It may be safely left to any one who will take stock of actual facts to compare the cases of damage to our valuable hill-roads, which result from landslips *arising* from too great loading of the soil with moisture from trees (not merely those arising from cuttings in soil which has no cohesion), and those which are caused by over widening ravines cut out in the denuded hill-side.

and planting with willow cuttings, poplar seedlings, and horse chestnuts, after which, if only for ornament sake, a sprinkling of deodar transplants should be put out. All classes of French authors support this principle. Nor is it difficult to understand, for it mainly rests on this fact that, while masonry structures, dikes and embankments, can only direct and restrain the force of floods, vegetation strikes at the root of the matter and diminishes the force itself. Engineering works are always more costly than works to restore vegetation. Moreover, they are at any moment liable to be destroyed should the force of the torrent exceed the maximum power of resistance allowed for. And experience tells us that, make what, allowance we will, it constantly happens that a flood tops the highest mark; and though it may afford consolation to our minds that such a flood had "never been witnessed by the oldest inhabitant," it affords none to our pockets.

It may here be noted that, not only has practice demonstrated, but by far the greater weight of authority allows that engineering works alone will not suffice. Dr. Brown quotes a memoir by a French engineer LADOUCETTE, with the comment of SURELL to the following effect:—

"The scheme* proposed resolves itself (he says) simply into digging for the torrent a straight canal through the centre of the deposit, and maintaining this canal by constant clearings. According to M. Ladoucette whatever may be the precautions proposed by the author for strengthening the hills by means of plantations and cuttings like continuous dykes, they will never *present sufficient resistance to erosion; still less will they hold* out against the undermining effects of the flood."

It is mentioned by M. Surell that the clearing out of torrents is always a difficult operation, on account of the great size of the stones and the hardness of the mud in which they are imbedded; and that this work which demands great waste of muscle, and entails great expense, produces no durable result. The smallest flood suffices to overturn all, and to throw the bed of deposit into its previous disorder. This scheme attributes all the ravages

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* R. in F. p. 77.

of torrents to the irregularity of their beds; and proposes as a simple and sufficient remedy to give to them a straight bed. Surell alleges that the scheme confounds cause and effect; and that torrents do not spread themselves hither and thither because they have not a straight bed; but they have not a straight bed because, continually depositing matter, they are forced to spread themselves hither and thither.

When M. LADOUCETTE himself tried to work on the Durance near Embrun, by making an enbankment on his principle it was found that the first heavy flood destroyed all his work. It is quite true that *while* plenty works are going on and the young forest acquiring a stature sufficient to enable it to regulate the water discharge, it is necessary to protect the banks of torrents and rivers by '*barrages*,' embankments, &c., but these are only *aids*, while the power of the forest is developing. It is the forest that creates the force by stopping the flow of water at the outset. Works on the banks do nothing to affect this: and consequently they must either be so massive and costly as to resist any possible force or else are perpetually liable to fail directly an unusual flood occurs which is just the very time when they are most required.

And thus M. Culmann's observations which follow are entirely correct. In 1856, when an unusual rainfall occurred, M. Culmann was deputed to examine and report on the torrents throughout Switzerland. He says :—"In Switzerland as elsewhere, the evil produced by torrents is not a necessary evil: it takes birth often from the waste and recklessness of the inhabitants. The principal remedy, and the only one which is decisive and definite, is the *boisement* or *gazonnement* which stifles the evil at its source. In regard to such (engineering) works the theory of M. Culmann says M. Cezanne, may thus be stated: *Barrages* are but a temporary expedient to be employed while awaiting *reboisement* : it is necessary to construct them in a series, commencing from below: when the first barrier is filled to the level with gravel, there should be constructed a second behind it, and so on continuously.*

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* R. in F. p. 842-85.

Lastly, I wish to quote the remarks of M. GENTIL, Engineer-in-Chief:—

"Embankments attempted on the *cones de dejection* at the issue of the gorges by which come down the materials carried off by the waters from the higher-lying lands, have always failed, or at best the effects produced by them have been but precarious. The dikes in a few years have disappeared under the rubbish from the mountain.

"But the Forest Administration has succeeded, by the consolidation of the soil, in the creation of a robust vegetation on the flanks of the *bassins de reception*. The results are assured: the case of the works at La Batie, at Sainte Marthe, at Resail, has demonstrated *most manifestly and most indisputably*, that it is quite possible not only to arrest *dejections*, but also to re-establish vegetation on mountains, the most ravaged by these torrents.

"From the time that the soil in the *bassin de reception* is consolidated, and by plantings and sowings and works of the Forest Administration the soil is fixed, material is no longer torn away and thrown into the current which transports it to the lower-lying parts.* The waters assume in some measure a regular *règime*, they come clear and free from mud upon the *cones de dejection*, they dig out there a stable bed for themselves by carrying away the less ponderous material; at this stage embankment becomes possible in the valley, and it is practicable at little expense to keep in one unchanging direction the flow of waters which no longer carry away the stones. Properties along the banks are then securely protected; they are no more exposed to a sudden disaster such as those of which we have so many examples; they recover with this security their money value; and the population re-assured may count upon their harvests.

"On the other hand, the fixing of the bed of the current permits the erection of bridges and aqueducts on the roads and highways; communication is protected against the frequent interruptions to which it was exposed when the torrent was in full activity; and, in fine—nor is this the least important result of the regeneration of the basin of reception—the principal rivers no

* I can only quote Dr. Brown's English as I find it in his book.

longer receive the masses of *dejection* which encumber their beds and create confusion in times of flood. In illustration of these results, which have been thus referred to in a general and summary way, may be cited the following facts :—

'The torrent of *Sainte-Marthe*, near Embrun, was threatening to extend its *dejections*, so as to cover the Imperial road No. 94. A proposal to construct a dyke on the left bank had been formally discussed; the expense of this was estimated at about 45,000 francs, and was considered that it should be met in part by the State, and in part by the proprietors on the river bank. But since the execution of the works of *reboisement*, in the basin of Sainte-Marthe, by the Forest Administration, this water-course has *lost its torrential character*, and has settled its bed in the *cone de dejection*, the embankment has become useless, and the project which had been under discussion has been entirely abandoned.

'The torrent of Riou-Bourdoux was noted as one of the formidable torrents of the High Alps; the quantity of material which the waters put in movement at every flood, had, in some measure, led to the abandonment of the construction of a bridge for the passage of the Imperial road No. 94; the Forest Administration has enclosed (*mis en defens*,) the basin of reception, and executed some works of consolidation and of *gazonnement*. The *regime* of the torrent has been in consequence so far changed, that, at little expense, the bed on the cone can be definitively settled, and a bridge erected for the Imperial road.

'I might bring forward other examples of what has been effected; those which have been given may suffice to make appreciable how complete and efficient are the results obtained.'"

Thus, there is a general consensus of opinion that engineering works alone are insufficient under this heading. I may conveniently (but it must be briefly) dispose of the question, what sort of re-clothing of vegetation is the best? The forest writers use three terms: *Reboisement* (which we have adopted in an anglicized form) means re-stocking with trees; *Buissonnement* means re-stocking with bushes; *Gazonnement* means

laying down turf;—not only grass, but a mixture of grass and all kinds of herbaceous plants. All are valuable in their way; and as regards the question between tree growth and bush growth it is obvious that the latter must be productive of the same results as the former, only in a less degree; also that the utility of bushes is as a rule less than that of trees. With turfing or *gazonnement* the case is different: an element of another nature comes into play. Planting works interfere with grazing, but putting down turf does not: hence people began loudly to exclaim that it was waste of money and an unnecessary infliction on the pastoral districts to plant trees—turf would do all that was required. That turf alone can be employed in regions *above* forest vegetation is obvious: that it is far better than nothing in all cases, is also true; that it is efficient in *some* cases is also not to be denied: the French laws consequently promote for *both* methods of clothing the mountain side.

M. Marschand (quoted by Dr. Brown) has the following observations on the subject*:—

"Many people suppose that on the steep parts of the Alps a good *gazonnement* would be enough to keep up the soil and put an end to torrents. Experience has shown me that *gazonnement* above is nearly always powerless to moderate sufficiently the action of water flowing over steep declivities.

"I have been surprised at storms when passing through meadows fit for being mowed, situated at 2,200 metres altitude, that is to say, above the forest region. After some minutes if the storm was pretty violent, the water ran off the turf, collecting in the depressions of the ground, and forming small clear torrents. On the 17th August 1869, in particular, I observed in the upper basin of the Tinee, in the Maritime Alps, a storm of wind and hail which hardly lasted half an-hour, but which gave rise in the meadows to a number of these little torrents, the junction of which would produce a very considerable rise in the Tinee.

"A storm, observed at the same point in October 1868, threw immense masses of water into the same river in spite

* R. in F. p. 99. See also the remarks of the Administration at p. 174.

of the perfect *gazonnement* of its upper basin; the same storm caused great havoc in the upper basin of the valley of Abries, among the pastures on the hill of Grange Commune. Two of my friends had great difficulty in crossing the meadows situated near the summit, so large were the torrents which had suddenly formed.

"All places mentioned are covered with very good turf, and the soil is formed of grey schist.

"It would be interesting and useful to ascertain the quantity of water which, falling with the rapidity of a thunder-shower, would be sufficient to saturate a turfed surface, but the quantity is very small, and depends on the steepness of the descent. This phenomenon is easily explained. Alpine turf, beaten down by cattle, is formed of small plants growing close together, the interlaced roots forming a sort of felt. When rain comes, it makes the rootlets swell, which, pressed together, imprison the soil and form a scarcely permeable covering, through which the water gradually passes only by means of capillarity and hydroscopicity. If the rain is slow and continuous, these two properties are enough to permit all the water to pass through. If on the contrary it is violent, the water runs over the surface without being absorbed.

"But, supposing the surface to be horizontal, the effect just described is also produced; the excess of fallen rain, however, lies on the herbage to be gradually absorbed, for the quantity of rain retained by the herbage is in inverse proportion to the slope of the ground, and varies continually.

"Turf, *from the special point of view which we occupy*, is chiefly useful in consolidating the soil; this end is partially attained, in so far as any surface whatever, when turfed, will always resist the direct action of the rain, but as a whole, it is not: the excess of the water absorbed unites, forms little streamlets, and according as the inequalities of the ground on which they occur are steep or narrow, the turf is attacked by the running water, the soil is laid bare at some one point, and, in a few minutes, there is the beginning of a ravine, which will always grow larger after every new storm if a remedy be not promptly applied."

In India, owing to our more luxuriant growth, it may generally be allowed that both scrub growth and herbage are wonderfully efficacious, but grasses vary very much in power; some species, especially those of lower elevations, having the *habit of growing in tufts or crowns, with bare soil beneath*, and these are very inferior as a protection, because the water action sets in between the tufts.

In France, I should say in conclusion, the result has been that the law of 1860 for *reboisement* has been supplemented by the law of 8th June 1864 for *gazonnement*. This law provides that in each case it is to be considered whether the land need be turfed, or partly turfed and partly planted, or wholly planted.

Section III.—The Procedure to be followed in dealing with Localities to be reboised.

The French law has various provisions for different classes of property, by which it seeks to induce private and corporate proprietors to undertake planting works. In this country at present we may practically dismiss these differences, and consider that in all cases reboisement works will have to be undertaken by State Agency.

In dealing with the subject, I shall consider the general plan of reboisement followed, whether we are dealing with a country actually cut up and ravaged by torrents, or with one which may be so threatened, and on which landslips and ravines have already made their appearance, or where the hill side shows *a tendency to slip away and discharge* masses of stones and earth.

The *first step* in any reboisement work is *to get complete control over the area to be treated*. This is a *sine quâ non* in all cases, whether we are trying to extinguish a torrent, or to reboise dry hills or any other work of the class. Having defined the limits of this area, clear out all grazing from such portion as you begin with, and stop the exercise of all rights whatever. The object is to encourage every blade of grass, every herb and root that can be got to sprout a little, to do its best to cover the ground and gradually to form, with its decaying

leaves, a little mould to support the better forms of vegetation that should follow.

Without this preliminary, no attempt can ever possibly succeed.*

On the value of vegetation I cannot forbear reproducing an extract from Marsh quoted by Dr. Brown.†

"Whenever a tract of country, once inhabited and cultivated by man," says Marsh, "is abandoned by him and by domestic animals, and surrendered to the undisturbed influences of spontaneous nature, its soil, sooner or later, clothes itself with herbaceous and arborescent plants, and, at no long interval, with a dense forest growth. Indeed, upon surfaces of *certain stability, and not absolutely precipitous inclination* the special conditions required for the spontaneous propagation of trees may all be negatively expressed and reduced to these three: Exemption from defect or excess of moisture from perpetual frost, and from the depredations of man and browsing quadrupeds. Where these requisites are secured, the hardest rock is as certain to be overgrown with wood as the most fertile plain; though, for obvious reasons, the process is slower in the former *than in the latter* case. Lichens and mosses first prepare the way for a more highly organized vegetation. They retain the moisture of rains and dews, and bring it to act in combination with the gasses evolved by their organic processes, in decomposing the surface of the rocks they cover; they arrest and confine the dust which the wind scatters over them, and their final decay adds new material to the soil already half formed beneath and upon them. A very thin stratum of mould is sufficient for the germination of seeds of the hardy evergreens and birches, the roots of which are often found in immediate contact with the rock, supplying their trees with nourishment from a soil deepened and enriched by the decomposition of their own foliage, or sending out long rootlets into the surrounding earth in search of juices to feed them."

* See this enforced in the French Government Circular of 1st June 1861. (R. in F. p. 166.

† R. in F. p. 325.

Connected with the subject of allowing the natural recovery of vegetation as a first step, it would be proper to study the question of *preventing* denudation in the first instance. I have made some remarks on this subject in a note on "Demarcation of Hill Forests" in this Magazine for January 1877.

I will only here refer the reader to page 57 of Dr. Brown's book.

It is laid down as a principle that the *total clearing* of a hillside can never be allowed where the slope is steeper than one in three; or which has three feet of base for every one foot in vertical height. That even this clearing should be so effected as to leave horizontal belts of uncleared land between, at least 30 feet broad, and more than this according as the slope is steeper and the chance of ravines forming, greater.

The area once protected, it is not desired to attempt tree growth all at once. Where the soil is very bad and bare, it is a legitimate part of the operation of reboisement, to sow weeds and anything that will grow. Lucerne has been sown with remarkable success. This is deserving of attention as the crop may be cut without uprooting, and the fodder may be sold or given to neighbours who are deprived of grazing by the reboisement operations.*

The extent of the area to be so operated on, of course, depends on what our object is; if it is to reboise a mountain slope that has been denuded, the area will indicate itself to the simplest observation. Supposing, however, we wish to control the action of a torrent which debouching into the plains, threatens great damage to a town or to the public roads and bridges. We have first to examine and enter on a map all the ultimate ramifications and sources of the torrent, and see which contribute most actively to the flood during the rains; and having noted the character of each and made remarks as to soil, &c., the line which takes in the whole of the sources, will represent the area to be dealt with.

The object is to determine the exact site of the source of mischief.

"By subjecting every one of the affluents to such an ex-

* R in F. 204 and 251.

amination, and following out this in all the upper ramifications of the river, it is easy to determine what are the main centres of the production of the stone or clay materials borne along by the river, which are the causes of the perturbation which has to be fought. By this procedure the evil is localised, determined, and circumscribed; and it is often astonishing to find how limited in extent, compared with the area of the basin, are the whole sources whence the gravel is obtained."*

The following extract, which is taken by Dr. Brown from Surell's Treatise well describes this part of the procedure :—

After insisting on the necessity, which I have already pointed out, for either stopping grazing, or restricting the number of the flocks and herds to what the reproductive vegetable power of the district can sustain, he recommends that the land to be defended against the ravages of the torrent should be marked out, by tracing, on each bank of the torrent, a continuous line, following all the windings of its course from the highest point of its commencement to its issue from the gorge. "The strip of land comprised between each of these lines, and the summit of the mountains, would constitute (says he) what I would call a *zone de defense*, enclosed against flocks and herds. The zones of the two banks, following the outline of the basin, would meet in the heights, and would begird the torrent like a girdle. The breadth varying with the slope and with the consistency of the soil, would be about 40 metres or 130 feet below; but it would increase rapidly as the zone rose on the mountain side, and it would end in embracing a space of 400 or 5C0 metres, or from a quarter to a third of a mile.

"This outline would require to follow, not only the principal branch of the torrent, but also the different secondary torrents which degorge into the first; following then the ravines which each of the secondary torrents receives, and going on thus from branch to branch, it would go on to the birthplace of the last threadlet of water. In this way the torrent would find itself begirt throughout the most minute of its ramifications. These

* R. in F., p. 124.

zones of defence, in penetrating the *bassin de réception*, will be enlarged; while on the other hand, as the ramifications are in this part more multiplied and more approximated, it will come to pass that neighbouring zones will join and even overlap each other, and their outlines will be lost in a common reign, which will cover the whole of this part of the mountain, without leaving there a void space. The zones of inclosure being thus determined, the first part of the operation is finished. But this is in some respects only the outline of the periphery of the work which is to be done.

"We have next to do with what may be the most active and prompt means of drawing vegetation over the whole surface *of this enclosure. For this purpose it should* be sown and planted with trees; where it may be impossible to raise trees at once, the growth of shrubs, bushes and thorns should be stimulated; but on the height where the zones include the whole extent of the *bassin de réception*, it is a forest which must be created. The best adapted kind of trees must be selected; recourse must be had to all modes of procedure, indeed even to modes of procedure which have yet to be discovered, and which go beyond experience. The work must be done any way and every way, and the end aimed at in these works ought to be to cover the *bassin de réception* by a forest which will every day become more dense, and which, extending itself step by step, will end in spreading even into the most hidden depths of the mountain.

Thus, then, it is in the highest parts that the works should be first undertaken, thence to be extended to the parts on a lower level. Not only should a commencement be made by planting the *bassin de reception* before giving attention to the lower zones, but even in this basin the commencement should be made in its highest ramifications. We should go above the last traces of the bed, up to the abrupt slopes furrowed with ravines which the water forms and deforms with each storm of rain; it is there that the first works should be established: we should afterwards—but only afterwards—carry them lower, but making sure first that the parts left are quite consolidated."

It may here be mentioned that where the conversion of the

whole area into close forest would affect the grazing of a district and put the people to great straights, it is a good plan to cover the ground partly with grass and herbage and partly with trees.

It is usual in such cases to cover the ground with grass and to establish at intervals strips or interrupted bands of trees, so as to allow the circulation of the cattle. Broad-leaved trees worked for coppice on a short rotation are recommended.* Compensation should be paid where necessary to reconcile the people with the temporary interference with grazing.

Generally speaking, the ground we have to operate on will be found to be unstable, easily washed away, liable to landships, &c., or will be cut up into a thousand fantastic shapes by rain water, as those who have seen the Pabbi hills or the *rakhs* in the Jhelum district of the Punjab will readily recollect. We have, therefore, to level these irregularities, at least to bring down unstable elevations, fill up intervening depressions and convert all chasms with ravines, rifts and prominences into general connected curves. Sometimes blasting will be necessary, but in the majority of cases, the spade and the pickaxe, for digging and levelling and throwing debris into hollows, will suffice.

Then we have to protect our levellings from being again cut up by the next violent fall of rain. This is done partly by staking, and partly by fascines. Staking may, in the hills, be extremely well done with large cuttings put in the loose bank in rows, such stakes to be of willow or some other species that will take root; or they may be dried stakes held together when necessary by a wattling of flexible branches, or may be hurdles put in at intervals. Experience will prove which are best adapted to the particular circumstances of the case.

When a stronger defence is required, what are called "barrages" will be useful. These are either made of fascines or of stone. The former are generally used when there is a smaller flood to restrain, or a smaller ravine to fill up.

Stone barrages are useful to force the water of a torrent to

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* R. in F., p. 315.

spread itself out in a shallow sheet. Such weirs are constructed in a series one above the other, beginning at the bottom.

The best form would appear to be that of a submergible weir, a horizontal sill strong enough to resist water wear which will force the waters to spread themselves out in a sheet, in doing which they lose their velocity and are forced to deposit above the weir, the material which they were carrying along.

But "barrages" are, as we have seen only useful to aid the work of vegetation, not to supersede it. In other words, it is idle to hope that without enclosing any area or giving vegetation a chance of spreading, we can restrain the action of torrents. I of course admit that light barrages, composed of hurdles, stakes and fascines, may be properly employed in the first stages of the work, to fill up hollows, small ravines and to consolidate unstable banks, but "barrages" erected across the course of the torrent itself are of no use till all works for clothing the soil with vegetation are well on foot.

The following extract correctly states the case:—

"These barricades will be like the completement of the works of extinction; they will serve to defend certain banks, till the vegetation has reclothed them over all their extent, and till the torrent itself shall have lost the greater part of its violence. They can be employed also to stop up the secondary ravines to intercept the little ramifications, to fill up small holes; in fine, to lead over the surface of the soil, and thus completly efface, those innumerable streamlets divided like the hair-like fibres of a root, which are really and indeed the root of the evil."

When dealing with banks cut up by water channels, one of the first things to do is to utilise the water to moisten the soil, and thus promote vegetation. This is done by taking off from the channel a great many little canals on either side, running at very gentle angles (otherwise there will be a dangerous rush of water in them). The earth thrown up out of the channels will be loose and moistened by the flow, and on it young plants may be put out or seeds sown, as the case may be. The extract continues:—

"By the same analogy it may be understood that the vegetation advancing always, and gaining each day upon the

ground, should descend on the banks and carpet them almost to the bottom of the bed, as has happened in many torrents; but the giving of permanence to the banks is a result of too great importance to be left thus to the caprices of the soil, and of the free will of nature. We come thus to a third department of the work. It is one in which it is especially necessary to redouble care and to multiply devices.

"To draw the vegetation over the banks they should be cut with small canals of irrigation derived from the torrent. These will impregnate with fertilizing humidity the land now rent and dry; they will break also the slope of the declivities, and serve to render them more stable, and soon they will disappear under the tufts of various plants brought to light by the water.

"The formation of these canals being extended ultimately to the summit of the bank, the water will thence penetrate the zones of enclosure and fertilise their soil. It is in the retention of the water, and in the possibility of opening everywhere and multiplying almost indefinitely provision for this, that rests in reality the whole future of the work.

A system of soil protection is described by Dr. Brown as inaugurated by a forest-guard named Jourdan, which deserves notice.

The system consists in applying fascines wherever there is a ravine forming, and the barriers of fascines are to be nearer to one another in proportion as the declivity is steeper and soil more friable.

A first bed of fascines is laid across the ravine; on this another set is piled, longwise, *i.e.* the points looking towards the summit of the hill. Then more transverse fascines follow, to such height as the locality may require, the lower fascines are held in their place by huge stones.

In dealing with slopes very unstable in character, it is reasonable, both to plant and to sow herbs at the same time.

In the first place, beds are prepared some 6 or 7 feet broad, not quite level, but slightly sloping inward, towards the mountain, so as to retain all the water possible; on these they plant young trees of 3 or 4 years' growth so close that the branches meet; they are planted very deep as a security against drought, and the

stems on being put in are cut down close to the ground. This pruning down is several times repeated. It has the effect of causing the roots to spread and become powerful, owing to the check of the upper growth.

According to slope, those beds may be made at a greater or less distance apart: the steeper the slope the less the distance. The space between is sown after ploughing or hoeing, with forage plants, and all manner of herbs. Lucerne has already been specially recommended, as its upper growth can be cut and sold or given to those whom the exclusion of grazing has affected, and the wide-spreading roots are invaluable in consolidating the soil.

In the case of very steep banks, hurdles and rows of stakes may be employed to retain the soil more effectually.

The beds alluded to must be well dug up, for 16 or 20 inches deep, and stones picked out where possible. It may be desirable to set hurdles against the bank along the inner edge of the bed, to prevent stones, &c., slipping down from above and crushing or covering the young plants.

In sowing forage and other seeds between the rows of young trees, a great variety should be introduced.*

Sowing broadcast on unprepared soil is rarely, if ever, successful.†

When the soil is very bad, hard and dry, the use of "potets" or prepared holes for planting is recommended.‡ The "potets" are 40 inches square and dug to 18—20 inches deep; they may be 6 or 7 feet apart or less; all stones are picked out and whatever good soil can be gathered in the vicinity is put in. Sowing or planting these potets can only be determined by the experience of the locality. Plants that develop long tap roots are to be preferred.

Nothing could be more hopeless in the way of work of this kind than the reboisement of Mont Faron behind Toulon, a detailed account of which was read to the Conference at Allahabad in 1873 (*vide* Vol. of proceedings, page 162).

If a further example is needed it may be found in the account

* R. in F. p. 271.
† R. in F. p. 273.
‡ R. in F. p. 284.

of reboising the Luberon which is a Crown Forest (Dep. des H. Alpes). It is situated on '*Neocomian*' belonging, according to Dr. Brown, to the lower chalk formation; the land is mostly bare, covered with heaps of rock, burned by the sun, and totally devoid of vegetable mould. Here they gathered together the little soil they could find into ridges and prevented it from falling down by layers of stones. Sowings were then effected on the ridges. "To one who has seen the sowings of the Luberon," says the Official Report of 1863, "no reboisement will appear impossible.

It may here be noted that in dealing with all difficult localities, good and well watched and recorded experiments must first be made, in all sorts of different places, by different methods and with different species. But full record and care are absolutely necessary. It is *not* an experiment to waste money, by doing what *primâ facie* is absurd, and making no note either of the steps taken, their cost, or their results.

I may here mention that for all works of this kind it is necessary to have well supervised and accessible nurseries, from which young plants can be obtained without exposing them to carriage for a long distance. Nurseries may be sheltered by frames covered with grass thatch.

It is also desirable to have a seed-house and a system of collecting seed, so as not to be in want of seed at the very moment when everything ought to be ready for sowing.

Short notes about planting may also be here given. One very good plan is "tuft-planting" (*pourette*). The earth raised is divided into clods, each containing several young plants, a fragment containing 2 or 3 plants broken off and planted out; one or more is almost sure to grow.*

In our hills where oaks are sown, it may be well to try a plan recommended, *viz:* to cause the acorn to germinate artificially during winter, to cut off the radicle, and sow the mutilated acorn in a seed bed. This favors the development of fibrous roots and checks the development of the tap root. This is of course not desirable, where a long tap

* R. in F. p. 193.

root is needed in arid soil, but where it is desired that the tree should take a quick hold on the soil.

In removing plants it is also found very useful to dip the loose roots into liquid clay before transport. Before putting out the transported plants into the places, it is said greatly to stimulate their vegetative power if the roots are soaked for several hours in urine.

As to the selection of locality for reboisement, it is to be recollected that where grazing can be with difficulty kept out for ever, it is not necessary to convert the whole "perimetre" into forest, it may be treated *partly* by "gazonnement", and partly by trees in alternate strips and belts, the latter being not con*tinuous, so as to allow of circulation of cattle* when the place is reopened to grazing, the trees being out of danger.

Above all things always commence the work where the chance of success is good, and where *results will be seen.* This will disarm popular objection and make the authorities also favorable. The sight of a bare place actually restored, does more than pages of argument. This was impressed on the Forest agents by the French Administration in carrying out the laws of reboisement.

The Administration directed that a good selection of ground for the first experiment should be made so as to "arrest the eye and convince the indifferent and the incredulous."*

For a general account of the progress of a work of reboisement I would invite the reader to study the account of the treatment of the Bourg D'Oisans given by Dr. Brown at page 270. And I shall conclude this paper by an extract describing the successful extinction of the St. Marthe torrent (already alluded to).

The torrent of St. Marthe is situated on the right bank of the Durance, and rises in Mt. Saint-Guillaume (nearly 8,350 feet above the sea level). Its course extends over about five miles to the point where it joins the river a little more than a mile below Embrun, and where the elevation is only 2,350 feet. In five

* Nos. R. in F. pp. 171-2.

miles therefore the torrent has a fall of 6,000 feet or above 1 in 5.

When the works were commenced on the *bassin dé reception* the surface of it was absolutely bare, and everywhere cut up by ravines. But as the upper part is formed of sandstone and of pretty hard compact lime stone, the disintegration was only superficial.

The *canal d'écoulement* is a narrow gorge, and has an extremely steep descent, all along which exist *berges vives* in a tumbling down condition. The upper half is formed of earth, stones, and blocks of rock which have been borne thither; the lower half traverses black marl almost in a state of clay or mud.

Everything necessary to produce the well-known effects of torrents is found in this torrent. The *bassin dé reception*, entirely denuded of vegetation, forms a funnel in which the waters, at the time of storms of rain, rush to a common centre almost instantaneously. The mass of waters precipitates itself on the steep declivities of the *thalweg* (line of water discharge,) from the very first, tearing away from the flanks of the upper hills large quantities of stones and rocks of all sizes. Lower down the flood takes up the black mud furnished by the washing away of the lower lying hills; and then, like an avalanche, which in some respects it resembles, it precipitates itself with a violence which nothing can resist, and debouches at the bottom of the valley at the extremity of the gorge which forms the summit of the *cave de dejection.* Fine properties in the environs of Embrun, of the value of at least 300,000 francs, an imperial road, with a bridge and dyke belonging to the State, of the value of more than 200,000 francs, and a district road of great importance, were all being threatened with destruction. Dykes had been constructed along the side of the torrent to protect the plain; but the bed of the torrent rose higher and higher still. It had been necessary to meet this by raising higher and higher the embankment, and it had now come to pass that the torrent was several metres above the level of the property along the banks. Although it was imprudent to raise the torrent still higher, a new scheme of embankment,

which it was estimated would cost 45,000 francs, had been formally discussed, and it was about to be carried out.

It was under such conditions that the torrent was attacked in 1865. From 1863 the whole of the basin, which measures 530 hectares, upwards of 1,200 acres had been enclosed (*mise en défens,*) with the consent of the Municipal Council of Embrun, though it had been opposed by the inhabitants of the hamlets on the sides of the torrents. These had in reality the greatest interest of all in the execution of the works. As their dwellings and their fields, drawn along with the general movement of the soil, were tending towards engulfment in the torrent.

The works began with an improvement of the basin. Two years of enclosure had prepared the ground. All the ravines were cut up into portions by more than 200 *barrages*; channels to lead off and disperse the water were cut; and seeds of forage plants were sown over places which required them.

Attention was then given to the consolidation of the hills bordering the *canal d'écoulement*. With this view there were constructed first, strong *barrages* in the high lying parts of these hills. The years 1865, 1866, and 1867 were employed in securing the command of the head of the torrent, and diminishing the violence of the flood. It would have been imprudent and almost impossible to construct *barrages* in the middle of the black slime of the lower-lying portion of the canal *d'écoulement,* inasmuch as the force of the flood would not have been sufficiently reduced at that time.

In 1868, it was considered that the last part of the work might be taken up with some chance of success. If matters had been less pressing this might have been deferred for one or two years more; but it was deemed of importance that the results should be made apparent.

In constructing the lower series of *barrages,* the work was begun anew from below, instead of being continued from above. First there were planted at the lower extremity strong *barrages* capable of withstanding the strongest floods. Others were then constructed successfully further up the torrent, and pretty near to each other, that each might give support to the one above it.

And in portion, as land was gained by each *barrage*, the hills were cut into shape by the pickaxe to give them the angle of stability.

In the same time that the principal water-course was thus being consolidated, *boisement* and *gazonnement* were carried out on the lateral slopes. The ravines were choked with small *barrages* of stones, with hurdles, and with *fascines*; and the ground was drained at spots where infiltrations of water were producing subterranean disintegration.

These works, carried on in combination with each other, have proved completely successful. The torrent is now (1870) extinguished. For two years the greatest storms of rain have deluged the basin, but have had no other effect than to occasion a moderate increase of the flow. This has carried off no material, nor has the stream overflowed its banks. All danger to the plain has disappeared.

THE SYNDICATE HAS DISSOLVED ITSELF.

The new scheme of embankment has been abandoned. The proprietors have again brought under culture all the lands previously invaded, and a few years ago they planted vines and orchards within the very embankments of the torrent. These facts are patent to all; and they have been officially certified by the *Service des Ponts et Chaussées*.

The expenditure, including that of 1868, has been 91,134 francs 24 centimes. The number of *barrages* constructed is 759. The total length of the *barrages vivants* and the hurdles is 32,270 metres. The length of roads, 9,400 metres. The length of channels to carry off and disperse the water, 1,117 metres. The extent of ground regenerated and restored is 400 hectares. The extent of what may be considered as regained and maintained is 300 hectares.

B. H. BADEN-POWELL, F.R.S.E.

Fungoid Diseases of Forest Trees.

By M. C. Cooke, M.A., L.L.D., &c.

It has long been admitted that parasitic fungi do exert an influence which is deleterious to growing plants. This has in recent years been so fully confirmed in such well-known instances as the potato disease, hop mildew, corn mildew, smut and bunt, that it is no longer necessary to adduce arguments in its support. Whether such influences are in a like manner injurious to hard wooded plants, such as shrubs and forest trees, is perhaps not so well established or so universally accepted. Nevertheless, that fungi are injurious even to forest trees, has been recognized in some European countries by the attention devoted to the subject in the State Departments, and Schools of Forestry, more or less under the control of the State. Undoubtedly we know less of the diseases of trees than of herbaceous plants, because they have been studied less, but there can be no doubt that parasitic fungi are injurious even to forest trees, and that the study of such a subject is worthy of the attention of Forest Officers in India as elsewhere. For these considerations we have consented to communicate to this journal a few suggestions to serve as aids to the study of a subject of so much collateral importance.

Experience has taught us that fungi may exercise an injurious influence in at least three different directions, *viz.*, (1) either by permeating the soil, and injuring or destroying the roots, or (2) by establishing themselves in the tissues of the plant, and developing themselves outwards as true endophytes, or (3) by a kind of external parasitism, more or less covering the leaves and young branches, choking the stomata, checking growth, destroying the healthy functions, and ultimately causing death. These three modes of attack suggest the classing of our remarks under the heads of (1) Root fungi, (2) Endophytes, and (3) Epiphytes.

Root Fungi.—Horticulturists and Foresters in Britain have long recognized the secret but deleterious influences of root fungi, as evidenced by the numerous and oft-repeated complaints which have appeared from time to time, over a period of many years, in the pages of the *Gardener's Chronicle* and other

journals devoted to horticulture. Vines have been described as suffering from attacks of root fungi. Shrubs withering and dying beneath the insiduous attacks of fungi at roots, and whole plantations of young trees being cut off by some unseen destroyer, which at length was discovered in the soil. Hundreds of instances are on record to substantiate the fact that conditions of fungi, mostly in the state of mycelium, or root-like threads and fibrils, can, and do, permeate the soil, and injure or destroy growing plants to a considerable extent. There is no external appearance of this enemy manifest, until the condition of the plant itself gives indication that something is going wrong. It is only by breaking and turning the soil that the cause is revealed, and it happens not unfrequently that the unaided eye is insufficient to detect its presence. Causes and cure are alike too little within the scope of human control.

Fungi of the mushroom type are known to be developed from a mass of delicate fibrils which penetrate and interlace the soil, and to this filamentous material, which to Fungologists is known by the name of Mycelium, the common name of "spawn" is applied. It is just this kind of substance which accomplishes all the mischief comprised under the term of "root fungi." It is not a complete and perfect fungus, but the "mycelium" or "spawn" of some such fungus as an Agaric, a species of *Polyporus* or some *Thelephora*. This kind of mycelium, or incipient fungus, is almost certain of development from rotting wood, decaying leaves, or vegetable matter of any kind during decomposition. Hence all soil containing vegetable substances in a state of decay contains the elements of root fungi. This may be illustrated by two or three recorded instances. Two Deodars were planted near the Director's house at the Royal Gardens at Kew, one grew, the other did not, and it was afterwards discovered that, where the latter had been planted an old cherry tree had been cut down; the inference was that the fungi on the dead wood left, had attacked the living roots of the Deodar, causing the tree to fall into ill health. This was adduced as the true explanation, why one tree often refuses to grow where another had stood before.*

* *Gardener's Chronicle*, 1865, p. 462.

A fine *Wellingtonia gigantea*, standing in the grounds of Portnall Park, was destroyed, and afterwards the cause of death investigated. A sickly hue spread over the branches, all that skill and intelligence could devise was done for it, but alas! its doom was fixed, and in a short time this much-cherished favourite was a dried stick. Fungous spawn had penetrated every part of its system, a white kind of net-work was found under the bark of all its roots, and it was believed that the enemy was some species of *Polyporus* or *Thelephora*, in the mycelioid condition. In commenting upon this incident the Rev. M. J. Berkeley remarks that he had a noble *Cupressus macrocarpa* affected in the same way. He recommended that in planting on the same spot, it would be prudent to trench the ground deeply, and get out, if possible, every fibre of the deep roots, as each fragment might be affected, and would perhaps propagate the mischief, even if the new tree were planted at some distance.*

Shortly after the above was recorded another instance appeared in the same journal. The writer says that early in the year (1865) he had some hundreds of Conifers, which he noticed were rapidly losing health, and assuming a sickly hue, which steadily increased. He saw that they were attacked by fungi, and that some means must at once be taken to check the evil. Many of the plants were 11 and 12 feet in height. The greater part of them consisted of Deodars, *Pinus excelsa*, *Abies Douglassii*, *Abies Menziesii*, and *Cupressus Lawsoniana*. The remainder were *Wellingtonias*, *Abies Webbiana*, *Abies morinda*, *Arbor vitæ*, *&c.* All were planted in a nursery, the soil of which was for the most part about one half shingle, and the sub-soil entirely of that description. He had all the plants taken up, and every particle of soil shaken from their roots. He found that every plant was attacked by fungi, and that most of them had lost at least two-thirds of their roots, which were entirely covered with, and penetrated by, minute thread-like processes, forming a thick net-work all over them, sometimes, indeed, assuming the appearance of small lumps of spawn. After the plants were taken up, he had the roots well-washed in

* *Gardener's Chronicle*, 1865, p. 1037.

pure water, until not a particle of spawn could be seen on them, what were left were then cut back to three or four inches beyond the decayed parts. On examining the soil in which the trees had been planted, he found partially decayed leaves and small pieces of decayed wood, which were doubtless the cause of the mischief. Leaf mould had been applied to give the plants a start, which however, as has been seen, was in the wrong direction. Every leaf and bit of wood was the nucleus of disease. He was compelled to plant again in the same ground, after removing the soil and putting maiden loam in its place. Trenches were opened, and the plants were well puddled in, and slaked in cases where they required such support. Some 1,000 plants were treated in this manner, to which was added syringing morning and evening in very hot weather. The loss was less than one per cent. The plants were lifted and re-planted at the latter end of March.*

This, and similar instances, induced some remarks by the Rev. M. J. Berkeley on the subject, and it must be remembered that this gentleman speaks with the experience of nearly half a century, largely devoted to the diseases of plants, especially of a fungoid character, and their antidotes. He wrote:—"Every day proves more clearly what great caution ought to be exercised in planting on ground which has formerly been occupied by trees. A few sceptical remarks are occasionally heard, leaning simply on mere negatives, but the positive proofs are too numerous and stringent to leave any room for doubt. We have now before us a portion of the roots of a *Wellingtonia*, which were in close proximity to an old decayed post, and are now densely clothed with fungous spawn, which is rapidly destroying the tree, one of an avenue of 160, and fears are entertained that the rest will suffer. Different remedies have been tried without success, and we feel convinced that any chemical which could reach the diseased roots through the soil, would soon destroy those roots which still remain sound. The only plan likely to succeed is to lift the trees carefully and prune away every diseased root. We have known this treatment successful, and can suggest no

* *Gardener's Chronicle*, 1865, p. 1061.

other. There is little doubt that a large portion of the larch rot is due to this cause, and we have been informed by an extensive forest owner in Scotland that, after a plantation of Scotch fir is cut down, it is useless re-planting it till the ground is covered with strong heather, by which time the old roots have lost their power of mischief. In this, as in many other instances, prevention is much easier than the cure. If trees must be planted where others have preceded them, there is little chance of success, except the ground is deeply trenched and every root removed."* †

It will probably be urged that on forest land, and especially in tropical countries, it is impracticable to suggest clearing the soil of old roots, stumps, and decaying vegetable matter. That it has always been the practice to leave all this kind of débris to rot and decay in the ground, and that, upon the whole, it does not prove deleterious. That coffee is constantly planted on such roughly-cleared forest land, with the rotting stumps left, and the soil covered with rotting twigs. And yet coffee plantations flourish, and nurseries of forest trees succeed under such conditions. It may be so, but the danger always exists, and if any temporary weakness or sickness should fall upon such a plantation, root fungi will then seize upon the weakened roots and demonstrate their presence and their power.

In the majority of cases recorded, in which death or disease has been caused by root fungi, the suffering trees have belonged to the *Coniferæ*, but they are by no means the only kind of tree subject to similar attacks. We have before us a record of a greengage tree which died, and was succeeded by a peach tree, which grew with the utmost luxuriance, but at once withered from the contact of the old roots. The ground was then most carefully trenched, but apparently not far enough, as a scarlet flowered chestnut, which was planted within their reach, and which for two years flowered well, though it was only a seedling of four or five years old, after flowering in 1866 caused great surprise by dying suddenly. The roots, even the

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* *Gardener's Chronicle*, 1865, p. 1153.

† This may be true in some cases, especially when the locality is not suited to the species, but it will certainly not hold good in the general form here given.—[THE EDITOR].

merest fibres, on examination were found covered with spawn which had run between the bark and the wood, and formed a white film. It is probable that the enemy was the mycelium of *Polyporus igneus*, which is white, but it is very rarely that an opportunity occurs of ascertaining to what species the destructive mycelium belongs.*

Another instance is recorded of the examination of the border of a conservatory, the sickly appearance of the vegetation planted therein having indicated something wrong. The soil from two inches to a foot in depth below the surface was found to be like a mass of snow with fungous spawn. Its origin was traced to some staves of a wooden tub which had been left in the border. The roots of Oranges, Camellias, Acacias, Clethras, and Neriums literally crumbled to pieces on being touched.†

Knowing what an insiduous foe we have to deal with in this kind of fungoid disease, it is not unnatural that we should sometimes suspect that in tea plantations and in coffee plantations, as well as in nurseries of forest trees, this enemy has been the secret cause of much mischief in the past, and that too little attention has been applied in this direction. Having now pointed out what to us appears to be a grave source of danger, we must leave the suggestions with Forest Officers to apply them in their own individual cases, and satisfy themselves that this form of disease is, or is not, one which affects them, or the districts under their care.

ENDOPHYTES are fungi which enter by any means into the substance of young and growing plants, and develope themselves outwardly, by bursting through the cuticle of the leaves and young branches, when they become prominent objects, distorting and at length killing the trees, or at least stunting and deforming them. Of this class are the species of *Peridermium* which attack the leaves and young branches of Conifers—or rather it should be said, they burst through and develope themselves on the leaves and twigs, scattering abroad their

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* *Gardener's Chronicle*, 1866, p. 1017.

† *Ib.* 1867, p. 105.

myriad spores in a yellow or orange-coloured dust. Such also are the species of *Podisoma* which cause gouty swellings of the branches of Junipers and Cypresses, and burst through the bark in gelatinous orange or brown protruberances. At a future time it may prove advantageous if we enter more into the details of this class of parasites, and especially as to their structure, mode of development, and reproduction, and such suggestions as may, from time to time, offer themselves as helps towards their eradication.

EPIPHYTES are those fungi which, by spreading over the surface of the leaves and other green parts of growing plants, choke up the stomata, check all transpiration and literally choke the plants to death. These fungi attack evergreen and deciduous trees alike, and are not less deleterious in their influences than the last named kind. Some have a glaucous, whitish, or mouldy appearance, as the numerous species of *Erysiphe*; whilst others are almost black, resembling a coating of soot, as the species of *Capnodium asterina, Meliola,* &c., and these like the former must receive special illustration.

Finally it may be permitted us to suggest that in order to render our further remarks and illustrations of these parasites as complete and practical as possible, it would be of considerable assistance if Forest Officers in all parts of India would kindly collect and forward to us, through the Inspector General, specimens of leaves and twigs of trees of all kinds which come under their knowledge, which are affected or injured by parasitic fungi. In all instances the Botanical name of the tree, locality, and date should be attached.

It is admitted that this is a somewhat difficult task, not easily accomplished by those who have paid no special attention to a complicated subject like that of fungi, but in the course of time the eye will become educated to detect at once diseases of fun origin, notwithstanding the difficulties which encompass all early efforts. As our communications to this journal proceed we hope to be able to remove some of the difficulties, and in a plain phraseology, denuded as much as possible of technicalities, to give such hints and suggestions as will enable Forest Officers in India to pursue this subject for themselves, and to ascertain

how far, and in what direction fungal diseases are prevalent and injurious to the forest vegetation of India.

INDIA MUSEUM, LONDON, *January 2nd*, 1877.

A River Officer's Journal on the Jhilam.

By F. O. Le Marchand.

The chief transit depôt or station to which all timber rafted down the river is taken for examination and record on the river is at Bagham, a place about 25 miles from Gújarkhán. This is reached by regular dâk on the Grand Trunk Road as far as Gújarkhán, after which we ride to Bagham. The return journey is down the Jhilam by boat.

Leaving Jhilam station, the Grand Trunk Road is level for the first six or seven miles out of Jhilam, when it gradually rises into a long low chain of hills, a continuation of the Salt Range, and after winding about for three or four miles, descends into a valley through which it continues for nearly seven or eight miles in almost a perfectly straight line.

The valley is beautifully green with rich cultivation, as far as the eye can see, and at every ten or twelve miles or so are Government rest-houses and "serais" for travellers.

Once more we cross a low ridge of sand-stone hills, another branch of the Salt Range; the bare bleak appearance of the ridge is most melancholy after the beautiful cultivation we have just passed. Not a tree or a shrub is visible; every now and again a solitary post may be seen to indicate the proposed Northern State Railway line: and yet this, I believe, is one of our "rakhs" called "reserves" reduced to this condition for the sake of "keeping every body happy" by refusing to place any restrictions on grazing or wood-cutting.

I arrived at Gújarkhán at dusk, a bath and the usual dâk bungalow dinner concluding the day. The ride next morning, however, made up for the disagreeableness endured the day before, and I enjoyed a splendid gallop of nearly twelve miles through a cultivated country, the quail and grey partridges calling all round, while occasionally a sly old jackal would steal away quietly across the road.

At the twelfth mile the scene changes, and the road (through a low range of hills) becomes bad and stony. To go out for a walk was impossible, so I did not get into camp till past 10 o'clock. The sun being very hot, and no tents up, I cleared out one of the new stables and out-houses we are building here, and made myself as comfortable as I might for the day.

Arrived at Baghám, my work now commenced. Above Baghám, the river sub-division extends to a distance of about sixty miles to a place called Salegrám, the first of the catching depôts, and the furthest point up the river from which rafting can be done. Between these two places there are seven or eight catching depôts, at distances of from five to ten miles apart. These points have been selected, owing to there being back-waters and eddies into which the logs are naturally carried; they are then secured by raftmen, who swim out after them on "mussaks" (inflated goat skins), they are finally tied up into rafts and brought down to the Baghám transit depôt. The ropes used for tying the rafts are made up of the "bhabbar" grass that grows on the hill sides near at hand, and the rafts are steered by rough oars made up of broken bits of wood caught floating down the river.

On arrival of the rafts at the transit depôt, the Forester in charge immediately proceeds with a pot of red paint (gerú) and marks each log with the letter of the catching depôt they are brought from, for instance, S shows they were caught at Salegrám, D from Dangully, B from Bul. This is necessary as different rates are paid for different distances. After marking the logs thus, they are measured on the water and the raftmen paid, they are then hauled up into the depôt, where the letter of the catching depôt is cut out on the logs, each log is remeasured, numbered, and rolled into sections according to its class and description. Waif timber is kept separate from Government timber, as at the close of the year when the accounts are made out, the Maharajah of Cashmere gets two-thirds of the *nett* proceeds of the sales of it (after deducting expenditure incurred in collecting it.) A register is kept in which each log is entered with its number, marks, and measurements. At the close of the catching season, these logs are despatched to the sale depôt.

With each raft that leaves, the raftman in charge is given a challán, in which is shown the description of each log, marks and measurements, name of raftman, date of despatch, and rafting material; the duplicate of it being despatched the day before to the depôt officer.

Besides the works enumerated above, others of a more harassing nature have to be attended to; there are no less than five other timber traders on the river whose logs are caught at the same places as ours, and whose rafts have to be inspected at the transit depôt, where the measurement and description of each log is entered daily in a book. Every quarter a statement of such timber is sent to the Conservator of Forests as imports from foreign territory. This, of course, gives us exactly five times as much work as we would have, could this statement be got out of the traders direct, but then, on the other hand, it prevents their stealing Government timber to a great extent. Here indeed is where all the disputes arise: rafts often come down with more timber than is stated in their challans, and the surplus is at once detained. Then again newly cut marks are sometimes discovered, which have probably been put on somewhere up the river, these also are seized until satisfactorily accounted for.

At certain appointed places the villagers are allowed to collect as firewood pieces caught floating down the river, they receiving in lieu of payment a quarter of all they catch. These heaps have frequently to be inspected, to prevent theft, and also to stop the villagers from smuggling in larger logs under the firewood pieces, which they are very fond of doing.

About a mile, or probably less, from the transit depôt, a very nice forest-house is being constructed on the top of a rocky hill; the sides of which, running perpendicularly down to the rushing river below, are nearly encircled by the waters. In the distance the rock looks like a young Gibraltar, only that it is black. From the summit the transit depôt and river, above and below for a long distance, are visible, and it is altogether a most picturesque spot.

The transit depôt is situated on a plain that once formed the bed of the river, but the stream changed its course, and

left a huge semi-circular plain, covered with round boulders. The river is now cutting into the opposite bank (in Cashmere territory), which towers over 200 feet above the level of the water, and large masses of stone and earth can be seen falling away daily. Under this cliff is one of the dangerous parts of the river; above it is a rapid, and the troubled waters strike the hill full in the centre, and curl back with great force, forming a nasty whirlpool into which the rafts are often carried and broken up.

I will presently give a description of the river and my journey down it, but meanwhile it may not be out of place here, to make a few remarks on the low hill forests that clothe both banks of the river Jhilam, and are, I believe, under the charge of the Forest Department.

From the foot of the Murree hills to within twelve miles of Jhilam (a distance of nearly sixty miles) is a long range of sandstone and boulder hills that run all along and form both banks of the river Jhilam, the east side being Cashmere, and the west British, territory.

Both these ranges are very fairly covered with phulai (*Acacia modesta*) and sanetta (*Dodonea viscosa, L.*) the latter growing to an extraordinary size, and in some places forming an almost impenetrable jungle. *Pinus longifolia* is scattered about in the forests, the first two stages out of Murree, and though large trees are not very numerous, there are any number of young saplings from two to twelve feet in height.

The population is small; there are only a few villages down the valleys on the west side of the range, the east (the side that faces the river) being for miles without a village; the conquence is that the forests facing the river are in a better condition than those on the opposite side of the range, they being less cut up.

These undoubtedly will be the forests from which we shall by and bye get most of our supply of fuel for the use of the Punjab Northern State Railway, and they should be strictly preserved.

The facilities for transport are considerable; the river which skirts the whole length of the forests is navigable by boats for

nine months in the year. During the remaining three, when the river is in flood and almost too rapid for boats, the wood could be brought down on rafts and landed at Bagham, where our transit depôt is, and boated down to Jhilam during the winter, or for the matter of that, Bagham might be made a sale depôt for the Pindee market; there is a fairly good road from it to Gújarkhán (twenty miles) past which the railway will run by and bye, and we hope soon! Some time ago the raftmen found it such a paying thing bringing down this firewood to Jhilam on their rafts, that numbers of them would hurry back to bring another supply sooner than wait to have their rafts measured and be paid for them. Most of the firewood was got out of the Cashmere territory, but as they could show no authority for being in possession of and bringing it down, I put a stop to it by threatening to confiscate any that passed Bagham.

I will now conclude with a description of my journey back by boat to Jhilam. The boat was of the shape usual on the Jhilam, and probably unchanged since the days of Alexander the Great. It is square at both ends, with bow and stern raised, and capable of holding two hundred maunds.* On starting, I was rather amused with a Hindu we had on board who, to appease the troubled waters, threw in a handful of sugar and repeated a prayer. There was a good stream on, and our boat rushed ahead at a great pace: we passed several nasty places where the current carried us with full force towards either a projecting rock or bend of a hill, and then just as you thought all was up with the boat and crew, it suddenly sheered off. The huge perpendicular rocks we passed were most picturesque and grand: sitting in the boat as it passed under the very foot of these immense cliffs, it was as much as you could do to see their tops; several of them were crowded with wild pigeon which had their nests in the holes and crevices of the rocks: hawks and kites also had made their homes in these safe fortresses, where nothing on earth could touch them, and in one or two of these places wherever a long

* *Vide* Punjab Products by Baden-Powell, Vol. II., p. 253, where there is a sketch of such a boat, and a detailed account of it.

ledge projects, can be seen numbers of black cormorants during the cold weather, which swim about the rapids and dive for fish.

About six or seven miles from Bagham we passed one of the Maharajah of Cashmere's forts ("Ramkot") rather an imposing looking building, situated on the top of a high cliff, and surrounded on two sides by the river. There are three or four of these forts up the river, between Jhilam and Murree, and all are occupied by the Maharajah's soldiers and guns. Soon after passing Fort Ramkot we reached Tangrot, the famous fishing-place, where some of the biggest fishes in the Punjab have been caught: the largest on record (*for a regular angler's book is kept up here to show all catches*) is 72-lbs.: the largest I ever caught weighed 52-lbs. During the fishing season, Tangrot is overrun with people who come up from all parts of India to try their luck, I have met people who actually came up from Calcutta, Hazaribagh, and Saugor. There is a capital dâk bungalow and accommodation for horses. It is here that the two rivers, the Púnch, which comes down through the Cashmere territory, and the Jhilam meet, and it is at "the meeting of the waters" that most of the big fishes have been landed.

I believe, about thirty miles up the Púnch are some very good *Pinus longifolia* (chíl) forests, out of which *thousands* of baihees (bed posts) are cut every year and floated down to Jhilam, Shahpur, Multan, and Kurachee. I have seen this river *covered* with these posts, which are about seven feet in length, and from six to eight inches in girth; they find a ready sale at Jhilam, Pind Dadun Khan, Shahpur and in fact at all the larger cities all along the river bank; their prices range from As. 2 to 4 each in their rough state.

After breakfast we again weighed anchor and started for Dulyál, the first of our sale depôts: an hour and a half's rowing brought us to Sultanpur, the last catching place on the river. The river from Tangrot to Sultanpur is very rapid, and winds about continually, the distance by road though only five miles, by river must be double that, to have taken an hour and half to do. At Sultanpur very little large timber is caught;

in fact, only the few logs that manage to get past the several catching places above; but the banks under the village are covered with any quantity of small pieces of firewood caught by the "Maneárs" (bracelet-makers), a race of people who never go in for agriculture, but gain their living entirely by making up the lacquered bracelets called "chúri," worn by women. At the close of the catching season about October or November, they get a quarter of all they catch as a reward for collecting it, and the remainder is put up to public auction, and often bought in by them also. Once past Sultanpur we were in pretty safe waters, and here again we passed another one of the Cashmere Rajah's forts called Mungla, *situated on the last hill near the river's edge. From this point* the country on both sides is flat, in another hour we were safely landed at Dulyál, which is within fourteen miles of Jhilam over a good kutcha road.

The reason for making a sale depôt here was for the purpose of supplying the Punjab Northern State Railway, who had taken up the old saw mills at this place. They were worked by the railway for about five years to saw up sleepers, but finding that the work could be done cheaper by hand-saws, they abandoned them. I remained the night at Dulyál and inspected the depôt during the evening. At Dulyál, there is another nice dâk bungalow made for the accommodation of enthusiastic anglers, for nobody but those who come expressly for fishing ever visits these spots.

The next morning we started again on our pleasant voyage. The river from this point divides into three streams, between each of which there are some excellent belas (islands) covered with beautiful sissú, which are under the charge of the Forest Department; these belas are partly self-sown, and where there are no sissú, the "pilchí" (tamarisk) grows profusely: the largest one I measured was twenty-five inches in maximum girth, and about twelve feet high. The three streams meet about 12 miles (by river) below Dulyál at a place called Gatiali: the timber can only be floated down them during the floods, but the net-work of islands or "chandas" formed by them has been of great service to us in preventing our

timber during heavy floods from getting past the sale depôt at Jhilam. The logs get stranded on them, and are afterwards collected and rafted down to Jhilam by a gang of coolies kept on by the contractor for this purpose. The drawback is that these logs come down without "chullàns," so that there is really no check whatever on the contractor, the *one* Forest guard allowed for this portion of the river being the only protection, and the contractor if hand-and-glove with the depôt subordinates, and the guard *below* Jhilam might easily dispose of the timber without fear of detection.*

Both banks of the river below Dulyál are flat and richly cultivated, and during the cold weather when the young corn is about four or five inches high, any quantity of wild fowl, such as geese and koolan can be seen feeding in the fields; ducks and teal are to be found all along the banks of the smaller streams, and below Gatiali during a hot sunshiny day, huge alligators like great logs can be seen basking on the sands. Within a couple of miles of the Jhilam station is one of the finest of the sissú islands, called the Bela Pírá Gháib, about 850 acres in extent, which is in charge of the river officer. It is a mixed artificial forest of sissú, mulberry, and *Execaria sebifera* of all ages from a year up to 20 years old. Here some interesting experiments are just being tried with the mulberry trees, which are planted under the largest sissú trees, so as to form an undergrowth. In one of these sissú islands below Jhilam, known as the Sailá bela, there is a dense growth of self-sown mulberry undergrowth, and in patches where the sissú trees have died out, the mulberry has taken its place. Soon after passing this bela, you come to the Jhilam Railway bridge, and then into the Government timber sale depôt.

A list is made of all logs that happen to get past Jhilam, and after the rafting season they are sold by public auction.

* We collected 1,392 logs *this* year from these chandas.

III.—Notes and Queries.

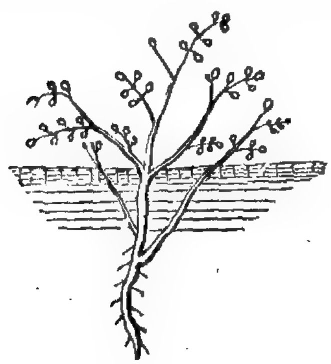
The Dalbergia Latifolia, does it produce Suckers?

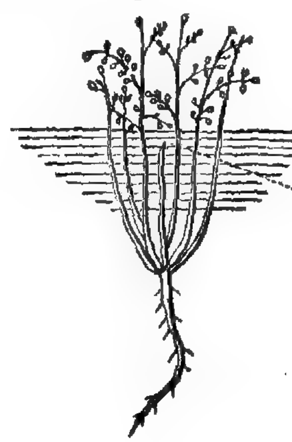
For a long time I had answered this question in the negative. I had myself had, until lately, only very limited opportunities of observing the growth of this valuable species, and in none of the books or reports, in which I had sought for information, had I ever met with any statement or hint suggesting in the remotest manner the possibility of the tree throwing up suckers. So I felt sure that it did not; if it did, would a whole generation of foresters have passed away without noticing and prominently recording so important and obvious a fact regarding one of our best known and most prized timber trees? *

Last year, however, my faith was considerably shaken. In a small experimental nursery I had formed at Punasa, there were some seed-beds which had been sown with shisham (our vernacular name for this species) in the rains of 1875. I had employed watering very sparingly, in some of the beds not at all, with the object of testing the hardihood of the tree in its infancy. Most of the seedlings died down to the ground during the early part of the hot weather; the rest put forth tiny leaves in April, as if after a great effort. I felt disheartened, and without digging up the roots to ascertain the real truth, at once concluded that the greater number were dead. The beds were neglected; my dog froliced and rolled about over them; men, amongst them myself, trod on them to take a short cut to beds of other species, that were doing better. When I returned to Punasa in July, after the rains had set in, to my amazement and intense delight, I found the much-abused beds covered with vigorous little shisham plants: scarcely 20 per cent. of the seedlings had died. On a close examination I observed that, in the majority of cases each apparently dead seedling had been replaced by a bouquet of from three to five,

* If I am mistaken in making this very uncharitable assertion, I shall be only too happy to be corrected.

and even six and seven shoots. I explained this to myself at the time by supposing that shisham yearlings possess an unusually large number of buds at the base of the young stalk; but when a few days later I dug up the plants to remove them into nursery lines, I found that while some of the shoots had grown up from the crown of the root, many had taken their rise up to as much as 5 inches below that point, and in some instances all the shoots of a single bouquet had sprung up some inches underground, the upper portion of the original taproot having withered and died down to the topmost shoot, leaving behind its dry and still undecomposed remains (see *a.* in subjoined figure).





All these lateral shoots were articulated with the original taproot and hence easily broke off. That these were suckers in the full sense of the term does not admit of a moment's doubt; but if any further evidence were necessary, the following two striking circumstances could be adduced: 1*stly.*—In removing the plants from the seed-bed, the taproot in some instances broke off short only two or three inches below the lowest lateral shoot; in two of these instances, where the portion left in the ground chanced to be protected by a light covering of soil, and owing probably also to other causes that escaped observation, a thin, delicate shoot was thrown up about a month later; and 2*ndly*—A few of the lateral shoots which had sprung up from a point about five inches below the surface of the soil, and the lower portion of which consequently partook of the nature of a root, were

successfully transplanted after being severed from the parent root.

But if the yearling with slender, almost herbaceous roots, throws up suckers, are we justified in predicating the same of the grown-up tree with stout, woody roots and thick, tough bark? The complete solution of this question mere chance threw in my way, only a week ago. Strolling along the Ganjal, opposite the squatter hamlet of Kairi, I observed at the bottom of a sort of rocky alcove or recess, that the stream had cut in the bank, dense tufts of dark green shining leaves. On descending to the bottom, I was much pleased to find that they were shisham leaves. In the recent floods of the river a tree of about 2 feet 6 inches girth was broken off about a foot above the roots, which were laid bare, some of them along nearly their whole length; others only here and there for some distance from the stern, by the same cause. The tufts just referred to grew on these exposed portions of the roots at intervals of from 2 to 4 feet. Just a little above this tree, on the perpendicular side of the bank, was another smaller shisham presenting the same strange sight.

I have since extended my observations to a large number of shisham trees growing under normal conditions, and have now satisfied myself that the case observed in the alcove on the Ganjal is by no means an exceptional or rare one, as regards the production of suckers, although it illustrates this characteristic of the species in the most complete and unique manner.

How to turn to account this remarkable property of a tree, which yields one of the finest timbers in the world, and is a hardy denizen of our dry, deciduous forest, growing on the rockiest and steepest slopes, it would be pure waste of time to tell the readers of the Indian Forester.

E. E. FERNANDEZ.

CAMP PARWAN-BARWANI,
25th February 1877.

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Forest Conservancy in its Popular Aspect.

It has often been observed that all new truth must first pass through the crucible of contradiction, doubt and even ridicule, before it issues into the realms of settled conviction.

Almost every branch of science in which great discoveries *have been made*, has passed through such an ordeal. Franklin was almost persecuted for his electrical discoveries. Harvey was long ridiculed for maintaining the circulation of the blood; and it would not be difficult to devote several pages in illustration of a host of similar cases. When however the maintenance of old error is bound up with the profit or convenience of a large section of the community, then is the effort to establish the truth, and get it acted upon *as* truth, indeed difficult.

The truths taught by Forest Science, unfortunately for progress, are involved in more than usual difficulties in the way of their acceptance.

In the first place, they are hardly evolvable from abstract considerations of vegetable physiology, chemistry, or atmospheric law. No body has ever realized *a priori* from a knowledge of such subjects only, that forests would exercise a preservative effect on soil, climate and water supply: the fact has only slowly worked its way into the convictions of a small section of society, by repeated observations of the results of forest destruction. And as nature suffers long and tries hard to combat the mischief, of course the evil only becomes rampant after a long struggle. During the progress of the evil it is not difficult to find large numbers of persons eagerly declaring that there is no evil at all. Every one who has read official papers in Burmah and other provinces, will call to mind how persistently some people denied the injury caused by forest fires, on the

ground that the fires always had been (this by the way is a most gratuitous assumption) and that there were flourishing forests notwithstanding.

It is probable that the progress of knowledge has driven out this idea to a great extent in India; but there are here and there some few who still argue for forest fires, just as in England some eccentric individual occasionally questions the fact that the earth is round, and makes strange bets, about observing the hull and masts of a barge approaching from the horizon line of a long straight canal, and so forth.

Just therefore in proportion as the *true facts of the case are* elicited by a careful and lengthened course of comparative observation, and cannot be put to the test of a few decisive and immediately crucial experiments, so does a conviction of the facts slowly establish itself. Nor is this all: it will usually be observed that even after people have ceased to venture openly to contradict the established conclusion, they nevertheless nourish a silent and half-smothered distrust, which results in their being very apathetic, coldly negative, and very easily persuaded to inactivity, in regard to the subject. Thus when the project of reboisement of the department of the Hautes Alpes and elsewhere, in 1860, first became generally accepted, it was so with a considerable amount of tacit doubt; so that immediately there was a little financial pressure, the expenditure on these works was at once reduced or stopped wholly: whereas if there had been a thorough and hearty conviction on the subject in the public mind, such a course would not have been thought of.

But then another and still greater difficulty presents itself;—there are an immense number of people who are at once totally ignorant of the real extent of the mischief done by non-conservation of forests, and intensely interested (as regards their immediate interest, beyond which they are unable to look) in doing it.

It is almost impossible to force on such people the conviction of the truths of forest science.

It will then be interesting to observe the effect which the general ignorance of the truths of forest economy, or their partial and feeble recognition, has on both rulers and ruled in this country. Both have their prejudices and belief, tacit or expressed, on the

subject of forests; both have also their interests or wishes which modify their action in the matter.

First as regards the people.

They are ignorant as we have seen of the practical truths established by forest science, the more so as they are blinded by a short-sighted idea of their own immediate interest. *All forest conservancy is therefore necessarily disliked.*

It is not to be supposed for one moment that the people at large are less hostile to forest conservancy in Europe, than they are in India.

It is true that in Europe the forest régime is usually attended with remarkably rigid restrictions regarding hunting, shooting, &c., and these intensify the popular dislike; so that fierce poaching frays and even attempts on the life of officials are not unknown .It is rarely in India that any great unpopularity attends the office of forester in any grade of the service, and attempts at forcible resistance have been very rare. The forest officer has this advantage that if the restrictions imposed by his rules are in themselves just and not really oppressive, they are soon accepted patiently as a part of the "dastur" or custom of the times, unless discontent is fostered, as it occasionally has been, by indiscreet official action.

But then the restriction is never liked at first: Even if it is, such an obvious matter as prohibiting barking trees, cutting slabs and torches from living pines, removing the "*humus*" soil from the forest, the restriction is not *popular;* and hence it is idle to speak of "carrying the people with us in our efforts to conserve," such phrases are mere folly. All that in India we can hope to do is, from a standpoint of necessarily superior knowledge, to ascertain facts, and define our restrictions and the areas within which they are enforced, with strict justice. Supposing, for instance, a village having 500 head of cattle has been accustomed to graze over a vast extent of forest land, without restriction. After considering the sort of ground and its grazing capabilities, and allowing a liberal average per head, the forest officer is satisfied that one-third of the original area is sufficient: is it to be supposed that the people will appreciate his facts however correctly and carefully ascertained? Not in the least.

The *fact of restriction*, reasonable or not, is what the popular mind feels, and this should always be borne in mind, but rarely is, by high officials of all grades, when visiting forest tracts. A number of people present petitions stating with much oriental latitude of expression their misery and the probability of their individual and collective extinction, owing to the pressure of the forest rules. The high authority is filled with a most proper feeling of compassion, and as the realities of forest economy have in many cases penetrated but very slightly to his inner conviction, a general order is issued, which embarrasses the entire administration of the district. Yet prudence would suggest to ask such questions as to what villages do the complainants belong? Are they poor or wealthy? Are they really so situated with regard to the forest that they are dependent in any degree on it, or could they get what they want by the simple trouble of going a mile or two further? Have they no common land of their own?* Are they respectable people or turbulent in regard to disobeying the forest rule generally? In the absence of such *data* for judgment the assumption is apt to be made that the forest rules (perhaps agreed to and sanctioned six months before) are too harsh, and an immediate, usually indefinite and often impracticable relaxation in favor of "*the* zemindars," "*the* villagers," or some such other general class, is directed.

And here I may mention a real cause of unpopularity of forest conservancy: it arises from the fact that the people continue to adhere to their own notion as to the proprietary right in the forest, while the Government declaration on the subject is, and has been for years past, at variance with such notion.

A good instance of this is afforded by the condition of the Rawulpindi and Hazara forests in the Punjab.

The boundary of civil jurisdiction between these districts is a purely arbitrary or technical one. The same tribal population extends over the Murree and Kahuta sub-districts in Rawulpindi as characterizes the adjoining hills of Hazara. The Khanpur forests of the latter district are not separated by any physical division from those in the Pindi district.

* In such cases as proved real, why not make a grant of forest to be common land out and out, or order it to be kept with clumps of trees here and there for grazing ground, instead of inflicting an indefinite burden on the Government Estates?

Yet in Hazara, the State recognized the proprietary right of the communities to the forest as a whole, reserving a right to manage the estates and to take a fixed or fixable share of the proceeds to repay such management. In Rawulpindi, judging from the earliest declarations of right in the rules of 1855-56, the State asserted *its* exclusive right to all *trees*, acknowledging only the rights of the people to grazing, firewood and timber for their own use, to be granted on application on payment of a tax or rate: and a portion of the fund so realized to be paid to the communities (not as any acknowledgment of their proprietary right but) "on condition of their co-operating with the officers of Government in enforcing the rules."

This state of things the people have, notwithstanding 20 years of its currency, never recognized. Long ago the payment of the share was stopped because the condition was not complied with, and the people to this day resent the treatment of occasional trespass on the forest rules for timber, brushwood and other produce, as *crimes*. They consider the forest *theirs*, in spite of the rules to the contrary: they ask how it is that there is one law for Hazara, and another for them? An enquiry into the *real* pre-annexation forest history of some provinces would be fraught with instruction.

But besides the short-sighted self-interest, which prevents ignorant populations from appreciating the necessity for forest conservancy, there is another connected subject to be considered; namely, that the effects of forest destruction do not always tell upon the locality of destruction itself, so much as on the lands at a distance: when this is so, you cannot expect the ignorant people to care about it. I need only instance the effect of mountain inundations in causing torrents, which do indeed furrow the hill sides into deep ravines and cause landslips, &c., but whose worst effects are seen in the vast masses of debris and stones they carry down into the valleys or plains below, de-fertilizing lands, destroying roads and bridges, altering the supply of water and the steady course of streams, and subjecting the inhabitants miles away to the fear of sudden floods, causing the river mouths to be blocked up by 'bars' formed of the detritus

carried down, and their navigability to be injured or destroyed.*

It will take centuries of teaching to diffuse anything like a popular acquaintance with, or recognition of, such considerations. In Europe indeed one great advantage has been obtained. Forest conservancy has been long enough recognized, to enable some important work in the way of plantations and restoration of denuded areas to be carried to completion, the results of which are palpable to the senses.

It is more than doubtful, whether centuries of civilization in Europe have put into the heads of the peasantry anything like a real conviction that a portion of the country ought to be under forest, and ought to be continuously maintained in that condition; but the most ignorant can realize an appeal to the senses: they can feel the difference of temperature, which a reboised tract causes: they cannot help seeing the change whereby what was once an occasionally running torrent, has become a permanent gentle stream, owing palpably to the process of clothing the slopes which surround its source, with foliage. Fortunately there are not wanting in various parts of Europe such ocular and tangible proofs of what forest growth effects.

In India, we have not yet reached so far. Indeed in the absence of a practicable forest law, and with the first years of our departmental existence spent in unrecorded experiments and tentative measures, and blighted by that Procrustean policy, which, without deigning to devote a moment's consideration to the varied condition of the different provinces and the different stages of forest destruction which characterized them, demanded a surplus revenue for each; thereby fixing deep the conviction that money making, not forest improvement, is the forester's road to promotion—with such difficulties, it is hardly to be expected that we should have *much* to show to demonstrate the results of forest conservancy. Something indeed we have; we can show at least in the Central Provinces, the Berars and elsewhere, the benefit of keeping out fire from the forest; and that is not a small thing in a country where the peasantry do not believe at all in damage by fire. Here and there too we have forests

* See Jules Clavé-Etudes sur L'Economic forestière. Paris, 1862, p. 31.

to which perfect rest from grazing has been allowed, and an almost perfect natural restoration been the consequence.

I may here take occasion to remark, that when under the law of reboisement of 1860, the Alpine districts were taken in hand, the forest directors of France wisely ordered that those circles of operation should be selected first which would surely succeed and were in such positions that their success would be notorious to the neighbourhood, being easily visited; it was considered that thus would the public discontent at the restrictions necessary to carry on reboisement works be much allayed, and people would be forced to admit the value of results which they saw with their own eyes.

It has often occurred to us, that we ought to imitate this course. The reboisement for instance of a portion of the range of hills crossing the Jhelum Railway line in the Punjab, and which hundreds and thousands of people would see, would do more good to the cause of forest conservancy, and encourage the official mind to be more courageous and decided in giving its support to forest work, then heaps of the most conclusive reports or the most unquestionably scientific arguments.*

Gradually disarming opposition in this way, we should advance to the only real method of attracting the people of India to forest management, *viz.*, the creation of communal forests —forests which would supply the wants of the community and would in all probability in the course of time put a surplus, not into the hands of individuals to be frittered away, but into a real common fund for the benefit of the village or township.

But it is impossible to pursue this subject here. We must hasten to the other part of the question in hand which relates to the effects produced on forest conservancy by the currency of certain opinions among the ruling authorities.

It is not at all probable that the mass of officials in India have not heard at least of the chief benefits which forest conservancy proposes to confer, and of the terrific evils which forest destruction brings about. Such books, as Mr. Marsh's "Nature as modified by action of man," are generally popular; some few may

* The Conservator of Forests in Bengal was guided by this principle, when drawing up the working plan for the Buxa plain reserve (see A. R. for 1874-75).—*The Editor.*

have read the work of Surell on Alpine torrents* and more still occasional articles on forest subjects in English and French Reviews. The general tone of feeling regarding forest matters is certainly very much altered, from what it was twenty or even ten years ago. Many officers then supported the idea that forest-fires did no harm; few would be found to do so now. Most people admit that all grazing is inimical to the restoration of forests, and that camels are worse than goats, goats worse than sheep, sheep worse than buffaloes (in most cases), and cows least harmful of all.

Yet this was not so always. The district officers in the Central Provinces *did* not, and those in Madras (it is said) do not to this day trouble themselves in the least to stop forest fires: and it is only of late years in the Central Provinces that their really intelligent exertions have stopped "Kumri" cultivation. In Burma district officials are not yet convinced in all cases that this cultivation (there called toung-yá) is a grand evil. Our cattle trespass law, only recently revised, still continues to enforce a fixed and ridiculous scale of fees for cattle pounds without reference to the forest question. We must still however be prepared to expect that (as before remarked) long after the open expression or maintenance of wrong views has ceased, a sort of unexpressed lingering over the old belief and a certain want of vigorous conviction resulting in languid action, will remain.

Just then as in the case of the populace we found a total ignorance of forestal truth, so in the official mind up to the highest, we find various degrees of disinclination towards vigorous conviction: and just as we find in the people the progress of conviction barred by self-interest, so is it with their rulers. Considerations of interest, such as the desire to have no complaints and to have everything snug and quiet in the district, to shew a good revenue sheet by yielding forest produce to indiscriminate user in return for a popularly low payment and so forth, affect their capacity for the reception of a sure belief in forest economy.

* The material of this and many other works on torrents have been made accessible to English readers by Dr. Crombie Brown in a work called "Reboisement in France." (H. S. King and Co., London.) We hope to review this work ere long.

The higher officials are naturally affected by the same feelings in a more generalized form. The district being expanded into the division, and the division into the province, the benefits of contented population, surplus revenue, and the absence of complicated questions of right remain, and of course expand in importance with the area to which they have reference; in other words, they multiply almost in geometrical proportion as we ascend from the smaller sphere to the aggregate;—from district management, to Provincial Government,—to Imperial Policy. Our present position under these conditions is the apparent absence of any definite line of policy with regard to Forest Conservancy. An examination of the higher official utterances will shew a tone varying frequently and very naturally, according to the pressure of the particular interest which the reference of the moment touches; but then the tone varies not unfrequently to the extent of forgetting or even contradicting, principles that ought not to be either forgotten or contradicted, under the pressure of any interests whatever.

Forest Officers not unfrequently find themselves in the position of people bound hand and foot and told to run. At one time surplus revenue is insisted on.* At another the closing of forests and a strictly conservative treatment which in general forests is incompatible with realization of revenue, is directed. Fearful of consequences, Forest Officers prefer positively to disobey the instructions, departmentally given, to close forests. In a large district of the Punjab, the clothing of a kind of brushwood (a small species of *Zizyphus*) locally called "Mallá" is of first rate importance in regenerating the scantily clothed fuel forests; yet in "rakhs" (as they are called) ordered to be *closed* for reproduction, this material was, year after year, allowed to be cut and sold! The officer in charge considered that he *could only* understand the order for closing so far as to be compatible with the order to make revenue.

At another time the absolute duty of the forester to show a visible improvement in the condition of the Crown Estates entrusted to his charge is urged; but should he commence to act

* It is remarkable, that no one has ventured to deal with the resolution of the *Conference* of 1873-74 on Finance! It seems to us that this is so because the arguments are unanswerable: if so, why not acknowledge it and act on them.

upon this, he is told that his instructions must in no wise interfere with *any one;* and that a happy population is to be regarded as of far higher consequence than flourishing forests.

The conservation of forests in short is usually agreed to and rules proclaimed without difficulty; but to put those schemes into effective operation becomes a matter of the utmost difficulty in case any objection is made in the course of the work: and of course objection *always will be* made (if listened to,) because, as already pointed out, ignorant people do not really know in the least whether they have got enough or *not;* all they regard is the fact that *they are* restricted to some extent by conservancy rules, and that they do not like it.

Another point here deserves notice. The chief feature of all Indian administration, especially in districts, divisions and departments, is its intensely idiosyncratic character. In some respects, and especially in the earlier days of settled Government, this feature is one of immense value; but as surely as it is not gradually supplemented (not displaced) by adherence to a definite policy from above, (thereby leaving the individual will and ability free to work *within* a prescribed boundary, but not to define that boundary for itself,) so surely does it become a danger. In forest matters it is so very greatly. Changes in the administration of districts are of course unavoidable; but each new comer has some new view as to how far the forest regime in his district is good either in principle or practice; and he sets to work accordingly, no defined policy from above restraining him. We shall not give names, but may allude here to a case of this kind in an important province, where in one district the forests had just been settled by a most competent and experienced settlement officer, where they had been thoroughly surveyed and mapped, where rules drawn up after the most exhaustive consideration had been sanctioned, and yet where the whole administration of those carefully provided for forests has been thrown into absolute confusion, apparently owing solely to the individual views of one particular officer who happened to come, in the course of administrative transfers, to the district charge.

Leaving however these general observations, we shall proceed to notice one very remarkable effect which has been produced on our forest area, and the principles on which it is treated, by the prevalence of certain (mistaken) views in by-gone days. The illustration relates to the Punjab. In nearly all the early settlements, or wherever in other ways the Government right to interfere with forest matters came up for determination, one prevailing notion will be found to underlie the orders of settlemen tand district officials; that notion was that it was practically sufficient to assert the right of the state to *all standing or growing trees:* so the grazing was to be unrestricted, and everything else, provided only the individual standing stock was not touched without a permit: in a few instances it seems to have struck the officer that reproduction might be necessary at some time, and a clause about closing one-third of the forest (which was rarely or never acted on at least effectually) was inserted.

Now this notion is based on a total disregard for the climatic use of forests, and on that radical misconception that the individual trees constitute the forest, instead of the important fact, that a forest is *one* whole, its atmosphere, its trees, its undergrowth, and its soil, being component members of it. The first consequence of such a notion has been to establish the selection-method (jardinage) of felling, in its worst form, everywhere without respect to its being adapted to the locality or not; so that all "aménagements" made have to be designed on the principle of conversion of an ill-used forest *into one worked for natural reproduction.*

The second consequence has been that, as the standing stock has disappeared by user, or by old age, nothing has replaced it, except in some few places, which happened to be naturally protected from the feet and mouths of cattle: in other places powerful nature has struggled to send up some vegetation, which goats have immediately browsed down into little hard mushroom-shaped lumps; then we are told triumphantly by the district officer that such and such a place is quite unworthy to be taken over by the forest department, it only produces a certain miserable stunted growth, and is of no other use but to afford grazing!

Let any person examine the curious hills known as the Salt range in the Punjab; the benefit to the plain lands below, if the mountain torrents were stayed and the slopes above the cultivation wooded, are simply incalculable. Yet the history of those hillsides is that they are doomed. Claimed as *private property* by contesting powerful tribes of Awans and others at settlement, the settlement officer, with a bold dash of policy, said "No; we are not going to have this sort of thing; no one shall have them: let the tracts be marked off, respect the standing trees, and you shall come in to graze as you like: moreover as there is lots of room for others besides you, we will let the public in with their flocks, provided they pay." The present denuded state of the hills is the natural and inevitable consequence; moreover the indiscriminate opening of vast areas of grazing ground, and the comparative difficulties of agriculture, rendered greater and greater as forest destruction progressed, tended to establish a pastoral rather than an agricutural regime, the former being of course the most detrimental to forest estates. Now that the hideous evil has become apparent, we are immediately brought face to face with the almost insurmountable difficulty of the case.

If it were merely the climatic conditions (which by forest officers are seen to be more important) of the Salt range, we should despair of making any impression on the higher official mind, until further years of writing, local demonstration of increasing torrents, and destruction of culturable lands, slowly brought the vivid conviction that we now entertain. But fortunately a large demand for fuel has arisen. How are we to meet it? The standing trees, the only declared right of the state, being cut down, the land is no longer available for forest treatment. But reproduction we must have, and consequently we are in a state of uncertainty, the Government urging us to take vigorous action, the authorities refusing to allow grazing to be stopped, and writing about petty questions as to who is to give permits to cut pennyworths of brushwood, while the real difficulty is not attempted to be solved.

The consequence of this initial misconception will necessitate the re-settlement of a large portion of the forest area

in the Punjab before any steps can be taken at all for the improvement and reboisement of the tracts.

Fortunately among the *Pinus longifolia* forests of Kangra, it was found possible by agreement with the people to get possession of certain forests; but there the pastôral difficulties were less, and in all probability the climatic influence of the forest much less, than on the higher ranges.

But while this peculiar notion of declaring only the standing trees the property of Government, may be confined to the Punjab, a conception of far wider extent has grown up in this shape that all forests should be classified unto "Reserved" and "*Unreserved*" *forest. On this principle it was the duty* of the forest department to select the very best forests and keep them as reserves free of all rights, &c., if possible; the rest was then designed to go either into one general class or into two somewhat similiar classes. If one, it is generally called a "district forest," which means forest that is given up to the villagers to do what they like with, subject to some very general restrictions, and which however in some places (*i.e.*, Central Provinces) are not altogether inefficient. When there are two classes, we have (1) "unreserved" and (2) "shâmilat," or guzara land; in which case the "unreserved" means a class of forest which is open to the exercise of rights, but still is to some extent under rules, and the State derives revenue for grazing, minor produce, and sales of timber and fuel. The "shâmilat, guzara land" or "village forest," means land given over to the communities to do what they like with, partition and clearing for cultivation even, being not disallowed.*

Now to a certain extent this division is perfectly just. It is quite right that we should obtain complete control over a portion of the forest rather than an incomplete control over the whole. It is quite right that as regards the production of timber, fuel, or any other commodity specifically, such as rubber, lac, bark, &c., &c., we should be able to take the produce from compact and fully productive areas, rather than glean them from an enormous extent of

* The evil of this has just been recognized in certain of the forests of Rawalpindee District in the Punjab.

sparsely productive land. It is also desirable for the comfort of people that the obnoxious regulations should be confined to as small a space as possible: but here the correctness of the notion stops. If it were known with any thing like reliable accuracy, what are the requirements (1) of internal consumption, (2) of trade and external consumption, (3) of the climate as regards the preservation of the water supply, suppression of torrents, landslips avalanches, &c., and if it were known that the "reserved" area alone was sufficient for the actual and prospective wants of the country:* it would then be a matter of course that the whole of the balance of forest land might be cleared off. But these facts are not ascertained yet; nevertheless the officials seem to regard the classification of forests effected as something final, instead of tentative. They look with satisfaction on the idea that there is a large area of unreserve, and are not aware, that the system of unreserve management is not one calculated to maintain the forest as such, but only to *retard the process of destruction* in those lands; the destruction nevertheless is gradually (and not always very gradually) going on. When shall we wake up to this fact, and commence to ascertain the statistical data necessary?

Whenever a demarcation of forest is attempted, it is invariably assumed that the interest of the grazing population directly affected by the forest regime is of greater importance than the forest interest. Such sentences as the following may frequently be read: "A happy and contented people is better than flourishing forests." That means that the content of the people locally affected, is better than a good state of forest. But if authorities really believed that the maintenance of a proper balance between forest land and culturable and pasture land was an essential economic truth, they would see that the proposition would be converted into this—"the content of people *locally affected* by forest reservation, is better than the welfare of the whole population whose condition is affected by the maintenance of the forest, whose land is saved for being eroded and dissected by ravines, whose water supply in streams is secured, whose

* Assuming, of course, that the reserved area was maintained in a condition of continuous and even increasing productiveness.

public roads and bridges are saved from being carried away by impetuous torrents coming down from denuded hillsides and so forth"—which is absurd. When there is a tendency to *the pastoral regime in hills which ought to be wooded, the* action of authority ought directly to discourage it or to divide the hill into such sections as would secure the forest interest *first.*

Instead of this we *always* assume the necessity of grazing and give up to forest whatever is left. Why should the pastoral interest be the first? The answer simply is, because the popular mind does not believe in or recognize, the value of forest in hills as benefitting the whole country below; therefore the immediate tangible interest of a small section of the community is preferred to the larger and unrealized interest.

Nature has laid down distribution of land for us which we would do well to study.

The mountains are clothed with wood: the tops above tree vegetation being open to grazing for the summer months: below that should follow belts of forest taking in the sources of supply of streams and nullahs. Below that again, we may have grazing and cultivation. Then come the lower hills to be occupied with sál forest, mixed forest, or *Pinus longifolia* forest according to the climatic position, and then we have culturable valleys and plains through which forests and grazing land have to be distributed chiefly according to local and export demands and less for climatic considerations: for in India (speaking very *generally) forests in the plains* have little more climatic effect than cultivation. Of course I do not go into such detail as to consider the desirability of planting islands in rivers, embankments, and so forth. I speak only of the broad distribution of land, which nature points out.

I do not also allude to any of the doubtful or unknown effects of forest, such as the increase of rainfall, but simply to those wellknown, and ascertained as surely as any scientific facts on earth;—*the preservation of the soil on hills, the prevention of torrents,* the regulation of the course of rivers, the preservation of a steady water-supply. Look at our Punjab lands with abandoned cultivation and beds of long dried up

streams, traceable to the outer Himalayan ridges; look at our great roads to Simla and elsewhere, the thousands spent annually on repairs on account of torrents which wash away the bridges, and landslips which destroy the roadway! Or look at the same thing even under the tropical verdure of the Eastern Himalaya below Darjeeling.

Yet all this is due to neglect of forests springing from unbelief in, or popular mistaken notions regarding, the natural place and use of forests.

I cannot here touch on the subject of agriculture, but the love of interspersing the forest with tracts either temporarily cleared for cultivation, or patches permanently brought under pick and plough, is due to the inveterate habit of the people preferring to get a small produce off an extended area of cultivation, than, by a system of farming, manuring and rotation of crops, to make a compact area yield the same or a larger return.

But our officials think it dreadful to put a stop to cultivation of hill tracts: whereas their steady action in the other direction would compel people gradually to the right action; this would then affect the area capable of yielding grass and fodder for cattle and so lessen the demand for grazing land in the forests. Is it premature then to collect statistics? We have a census of population; let us collect data of consumption of timber, small building wood, fuel, and brush wood per house; let us ascertain the number of cattle, the grass yield of our waste land and grazing grounds, and the quantity of land really needed for the yield of such grazing. We are allowing hill lands to be burned and cleared for cultivation without any one examining to see whether the land lies at a suitable angle of slope, or whether its clearance on other grounds is wise. In short, at present we are working with our "Reserve" and "Unreserve" in almost *Cimerian* darkness.

B. H. B. P.

The Forests and Flora of the Nilgiris.

BY LIEUT.-COL. BEDDOME,
Conservator of Forests, Madras.

THE Nilgiri mountains, rising to upwards of 8,000 feet and having a rainfall of less than 40 inches on some of the driest parts of the eastern side, and 300 inches on the moistest parts of the western slopes, possess, as might be expected, a very varied and interesting flora exceedingly numerous in genera and species. With the exception of the dense evergreen moist forests on the western slopes, the whole area has been well explored by Botanists, and it is probable that there are no plants now botanically unknown on the plateau and the deciduous forests of the slopes; but this cannot be said of the heavy moist forests of the western slopes; they are of immense extent, very difficult to get at and very feverish at the lower elevations, and as there are no habitations, inhabitants or supplies of any sort the visits of Botanists, who have often been attracted to them, have been generally of a flying nature. The trees in these tracts attain an immense size, 200 to 250 feet in height, and it is of course no easy matter to obtain their flowers, and there can be no doubt that there are still a good many undescribed species awaiting the Botanist; some flower in the cold season, some in the hot season and some in the rains, some few are in flower all the year round, but it is believed that the majority flower between February and the middle of May, which is the most unhealthy time of the year. The shrubs, creepers and herbaceous plants in these tracts are pretty wellknown, but a careful search at any season of the year would undoubtedly be rewarded by some novelties.

Botanically we may divide these hills into 4 tracts, each having its own flora, very few species of which encroach upon the other tracts.

1.—*The Deciduous Forests of the Slopes.*

These are of much the same character as the dry forests of the lesser hills and plains of the Presidency; the trees are all more or less deciduous in the dry months of January, February, and March, but the forests are never entirely bare, like the woods

and forests in Europe in the winter. Many trees, such as the Erythrinas, Butea frondosa, the 3 Dalbergias, Schleichera, Bignonia xylocarpa, Odina Wodier, Terminalia belerica and others burst into flower in February, and leaf themselves rapidly afterwards, before many other trees have finished shedding their leaves, but still these tracts have a very forlorn appearance at this season and fire often sweeps through them greatly to the disgust of the forester. In these tracts a very great proportion of the tropical trees of the presidency are to be met with, and about the lowest portions very many of the tropical shrubs and weeds, which do not belong at all to our Alpine flora, *such as the weeds amongst Capparids, the small milk* worts (Polygalas), the herbs and shrubs of Malvaceœ, the Grewias and herbs of Tiliaceœ, Zizyphus several species, Vitis many species, Cardiospermum, Leguminous weeds and herbs, most of the Cucurbitaceœ, many of the Compositæ, Convolvulaceœ, Scrophulariaceœ, Amarantaceœ, Commelynaceœ, and a large proportion of the sedges and grasses.

The trees most characteristic of those tracts are the following:—

Dillenia pentagyna.
Cochlospermum gossypium.
Kydia calycina.
Bombax Malabaricum.
Sterculia fœtida.
Eriolœna Hookeriana.
Boswellia serrata.
Garuga pinnata.
Cedrela Toona.
Chloroxylon swietenia.
Elœodendron glaucum.
Schleichera trijuga.
Buchanania latifolia.
Mundulea suberosa.
Butea frondosa.
Dalbergia latifolia and paniculata.
Pterocarpus marsupium.
Hardwickia binata.

Xylia dolabriformis.
Acacia many species.
Albizzia odoratissima and amara.
Terminalia *tomentosa, paniculata, belerica and chebula.*
Anogeissus latifolius.
Careya arborea.
Lagerstrœmia microcarpa and reginæ.
Adina *cordifolia.*
Stephegyne parvifolia.
Bignonia xylocarpa.
Tectona grandis.
Gmelina arborea.
Phyllanthus emblica.
Sponia Wightii.
Bambusa arundinacea. } Bamboos.
Dendrocalamus strictus. }

These tracts yield many of the most valuable timbers of the Presidency, of which the following may be said to be the most important:—

Cedrela Toona (White Cedar.)
Chloroxylon Swietenia *(the Satin-wood.)*
Schleichera trijuga (Puva.)
Dalbergia latifolia (the Black-wood or Rose-wood.)
Pterocarpus marsupium (Vengay.)
Hardwickia binata (Achà.)
Xylia dolabriformis (Irul.)
Albizzia odoratissima (Karangalli.)
Terminalia tomentosa (Matti.)
Lagerstrœmia microcarpa (Ventek.)
Tectona grandis (Teak.)
Gmelina arborea.
Phyllanthus emblica (Nelli.)
Santalum album (Sandal-wood.)

2.—*The Moist Evergreen Forests of the Slopes.*

These are grandest on the western slopes and between 3,000 and 4,000 feet elevation, where the trees often attain 200 and

250 feet in height; they are all evergreen and the great variety of foliage and color render them exceedingly beautiful, some of the young leaves coming out pure white, others a bright crimson, others all possible tints of brown, yellow, red and green. These tracts are exceedingly moist from the first showers in March till the end of December, and during that season abound with leeches. The trees are often covered with epiphytic orchids, ferns, mosses, balsams, and there is a glorious profusion of rattans, tree ferns, climbing ferns, and fine creepers, but what may be said to be most characteristic of these forests is the genus Strobilanthes (Acanthaceæ), large shrubs which form the principal underwood and of which 29 species are found on these hills. Some of these flower every year, others however only after a growth of 6 or 7 years, when they die down and renew themselves from seed; they almost all have showy flowers, and many are very beautiful. The 2 palms Caryotaurens and Arenga Wightii are very conspicuous in these tracts, also several species of rattan, (Calamus), and 2 very fine reed-bamboos, Oxytenanthera Thwaitesii (Munro) and Teinostachyum Wightii (a very handsome broad-leaved species described by Munro as a Bambusa from specimens only in leaf.) Ferns are in great profusion including several tree ferns, amongst which the Alsophila crinita (not yet introduced into English hot-houses) is unmatched in any country; very beautiful Sonerilas and Balsams are also in profusion. Guttiferœ, Rubiaceæ and Euphorbiaceœ are the orders perhaps most copiously represented (next to Acanthaceœ) the first by trees, the 2 latter by shrubs and trees.

Above 4,000 feet these forests begin to decrease in size, and towards the plateau they gradually pass into what will be treated of as *the sholas*.

The following is a list of the trees most characteristic of these forests:—

Polyalthia coffeoides.
Garcinia cambogia and Morella.
Calophyllum tomentosum.
Mesua speciosa and Coromandelina.
Pœciloneuron Indicum.
Dipterocarpus turbinatus?

Hopea parviflora and Malabarica.
Vateria Indica.
Cullenia exceloa.
Leptonychia moaccuroides.
Chickrassia tabularis.
Canarium strictum.
Aglaia Roxburghiana.
Beddomea Indica and simplicifolia.
Gomphandra axillaris and polymorpha.
Enonymus Indicus and angulatus.
Lophopetalum Wightianum.
Harpullia cupanoides.
Acrocarpus fraxinifolius.
Humboldtia Brunonis and Vahliana.
Saprosma fragrans, Wightii and glomerata.
Bassia elliptica.
Pajanelia Rheedii.
Myristica laurifolia and corticosa.
Alsceodaphne semicarpifolia.
Actinodaphne salicina.
Cryptocarya Wightiana.
Actephila excelsa.
Sarcoclinium longifolium.
Agrostistachys Indica.
Baccaurea sapida.
Ostodes Zeylanica.
Cephalocroton Indicum.
Bischoffia Javanica.
Hemicyclia venusta.
Artocarpus hirsutus.
Gironniera reticulata.
Laportea crenulata.

The timbers as a rule are not of such good quality as those in the deciduous forests, but there are valuable timbers of which the following are the chief :—

Calophyllum tomentosum (Poon spar.)
Mesua 2 species (Iron-wood.)
Hopea parviflora. (Kiral boghi.)

Hopea Malabarica. (Kiral boghi.)
Chickrassia tabularis (Chittagong wood.)
Acrocarpus fraxinifolius (Red Cedar, or Shingle Tree.)
Diospyros Ebenum (Ebony.)
Artocarpus hirsutus (Angelli or Ayni.)
Gironniera reticulata (Kho mangee.)

These moist forests never reach quite down to the plains any where round the Nilgiris, though they do so in parts of South Canara, Coorg and Travancore; they always give way, at 1,000 or more feet from the base, to deciduous forest or tracts composed of nothing but reed-bamboos (*Teinostachyum Wightii.)*

3.—The Sholas or Woods of the Plateau.

These are very similar in character to the moist evergreen forests of the slopes, but being at a higher elevation, the trees are of different genera and species, and their growth is much smaller, 80 feet being much beyond the average height; they are all evergreen, and the tints, from the new growth at certain seasons, very beautiful.

Myrtaceæ, Lauraceæ and Styraceæ are the orders most represented by trees, and the undergrowth is chiefly composed of Rubiaceous shrubs and Strobilanthes (Acanthaceæ.)

The following are the principal trees growing in these sholas :—

Michelia Nilagirica.
Hydnocarpus alpina.
Gordonia obtusa.
Elæocarpus oblongus-tabercnlatus and ferrugineus.
Melicope Indica.
Heynea trijuga.
Gomphandra axillaris.
Apodytes Benthamiana.
Ilex Wightiana and denticulata.
Enonymous crenulatus.
Microtropis ramiflora and densiflora.
Turpinia pomifera.
Meliosma Arnoltiana and pungens.
Photinea Notoniana and Lindleyana.

Eugenia, many species.
Pentapanax Leschenaultii.
Polyscias acuminata.
Heptapleurum racemosum, rostratum, obovatum and venulosum.
Viburnum punctatum, erubescens, hebanthum and coriaceum.
Vaccinium Leschenaultii and Neilgherrense.
Sapota elengioides.
Symplocos, many species.
Lasiosiphon eriocephalus.
Machilus macrantha.
Phœbe Wightii.
Cinnamomum Zeylanicum var Wightii.
Tetranthera Wightiana.
Litsœa Zeylanica.
Glochidion, several species.

The timbers are of much less value than in either of the other tracts; the following are those chiefly in use :—

Hydnocarpus alpina.
Gordonia obtusa.
Ternstrœmia Japonica.
Elœocarpus oblongus.
Ilex Wightiana.
Eugenia several species.
Enonymus crenulatus.

Ferns and mosses abound amongst the former. Alsophila latebrosa, a tree fern, is abundant. Orchids are very poorly represented. There is one species of reed bamboo (Arundinaria Wightiana) and some shrubby Balsams and Begonias, and the following herbaceous plants may be enumerated as very characteristic :—

Desmodium strangulatum.
Crotalaria barbata.
,, fragaria, Indica and elatior.
Sonerila speciosa.
Hydrocotyle Javanica.
Sanicula Europœa

Senecio corymbosus.
Chrysogonum heterophyllum.
„ Halenia Perottetii.
Pogostemon rotundatus.
„ speciosus.
Gerardinia Leschenaultii.
Elatostema diversifolia.
„ sessile.
Pilea Wightii.
Chamabainia cuspidata.

4.—*The Grass Land of the Plateau.*

This is covered with many coarse species of grass, which are quite burnt up with the frost and sun in December and January; after the first showers in March the growth is very rapid and numerous herbaceous plants spring up. The following are the most characteristic herbaceous plants:—

Anemone rivalis.
Ranunculus reniformis.
„ diffusus.
„ Wallichianus.
Viola serpens.
Impatiens Beddomei.
„ Chinensis.
„ inconspicua.
„ tomentosa.
Crotalaria formosa.
Indigofera pedicellata.
Flemingia procumbens.
Potentilla Kleiniana.
„ Leschenaultiana.
„ supina.
Drosera Burmanni.
„ Indica.
„ lunata.
Sonerila grandiflora.
Pimpinella Leschenaultii.
Heracleum rigens.
Anaphalis, several species.
Gnaphalium hypoleucum.
„ marcescens.
Senecio several species.
Gentiana pedicellata.
Ophelia corymbosa.
„ minor.
Micromeria biflora.
Prunella vulgaris,
Pedicularis Perottetii.
„ Zeylanica.
Satyrium Nepalense.
„ Wightianum.
Habenaria, many species.
Lilium Wallichianum.
„ Neilgherrense.
Pteris aquilina.
Gleichenia dichotoma.

Trees are only here and there loosely scattered about these *tracts*; *these consist chiefly* of Rhododendron arboreum, Salix tetrasperma, Celtis serotina, Pittosporum 2 species, Dodonœa viscosa and Wendlandia Notoniana.

The following are *the most characteristic shrubs*:—

Berberis Nepalensis.	Osbeckia Wightiana.
,, *Aristata.*	Hedyotis Lawsoniœ.
Hypericum Mysorense.	,, stylosa.
,, Hookerianum.	,, articularis.
Eurya Japonica.	,, *fruticosa.*
Indigofera pulchella.	,, pruinosa,
Desmodium rufescens.	Lobelia excelsa.
Atylosia Candollei.	Gualtheria fragrantissima.
Sophora Glauca.	Ligustrum Perottetii.
Cassia *Timoriensis.*	,, *robustum.*
,, tomentosa.	Jasminum revolutum.
Rubus lasiocarpus.	Clerodendron serratum.
,, flavus.	Leucas, several species.
,, rugosus.	Elœagnus latifolia.
Rosa Leschenaultiana.	Strobilanthes *sessilis.*
Cotoneaster buxifolia.	,, sessiloides.
Rhodomyrtus tomentosa.	,, kunthianus.
Osbeckia Gardneriana.	

The latter plant is often gregarious and covers several acres in extent, and when out in flower is one sheet of blue, and some people say that it is from this that the Nilgiris or Blue Hills derived their name.

The following may be enumerated as the most beautiful plants found on these hills:—

Fagræa Coromandelina (*slopes*).
Rhododendron arboreum (plateau).
Ceropegia Decaisneana (Sispara ghât).
,, elegans (Coonoor.)
Exacum Perottetii (Coonoor).
Œginetia pedunculata (northern slopes).
Impatiens acaulis } (Sispara ghât.)
,, rivalis }

Impatiens Denisonii } Sispara ghât.
„ Jerdoniæ }
„ Maculata (Pycarah.)
„ latifolia } (Kotagherry and Coonoor.)
„ fruticosa }
Vigna Wightii (northern slopes).
Bauhinia Benthamii (Sispara ghât, foot).
Osbeckia Gardneriana } (plateau.)
„ Wightiana }
Sonerila grandiflora (Avalanche).
„ speciosa (Ootacamund).
„ elegans } (Sispara ghât.)
„ versicolor }
„ axilliaris }
Passiflora Leschenaultii (Coonoor).
Panetta siphonantha? (Sispara ghât).
Saprosma fragrans „
Hamiltonia suaveolens (Kulhutty ghât).
Vaccinium Leschenaultii (plateau).
„ Neilgherrense „
Lysimachia Japonica „
Symplocos pulchra (Sispara ghât).
Jasminum revolutum (plateau).
Alstonia Venenata (Coonoor ghât.)
Beaumatia Jerdoniana (northern slopes.)
Hoya pauciflora (Sispara ghât).
Boncorosia diffusa (foot of hills southern side.)
„ Umbellata „
Porana racemosa (western slopes.)
Rivea tiliæfolia } (foot of hills, western slopes.)
Ipomea campanulata }
Argyreia splendens } (western slopes.)
„ speciosa }
Ipomea campanulata } (southern slopes.)
„ vitifolia }
Solanum ferox (northern slopes).
„ Wightii (Coonoor).
Torenia Asiatica (Sispara ghât).

Pedicularis Perottetii (Sispara).
Æschynanthus Zeylanica (Sispara ghât).
Klugia notoniana (Coonoor Ghât).
Pajanelia Rheedii (western slopes.)
Thunbergia Hawteyneana (Kotagherry).
" Mysorensis } (western slopes.)
" Wightiana }
Strobilanthes *gossypinus (Sispara)*.
" luridus (Neddwatam).
" tristis (Sispara ghât).
" sexennis (Ootacamund).
" *pulcherrimus (Neddivatam)*.
" paniculatus (western slopes).
" violaceus (Sispara).
Barleria involucrata (Coonoor ghât).
Hedychium coronarium (western slopes).
Alpinia Rheedii.
Musa ornata.
Gloriosa superba (southern slopes).
Lilium Wallichianum.
" " var Neilgherrense.

All the above are well worthy of introduction into gardens and hot houses.

The orchids are very poor compared to those of the Himalayas and Birma, but the following are the best and well worthy of cultivation.

Dendrobium aqueum (western slopes.)
Cœlogyne all the species (plateau).
Arundina bambusifolia (western slopes).
Ipsia Malabarica.
Cyrtoptera flava } (western slopes.)
" fusca }
Kanda spathulata } (northern slopes.)
" Roxburghii }
Ærides Wightiana (western slopes.)
" Lindleyana (Kartary and Coonoor).
Calanthe Masuca (plateau in shades).
Platanthera Susannœ (northern slopes).

176 Ferns have been detected on these hills, and probably others as yet only known from other districts will yet be discovered on the western slopes. Two of these Ferns, Lastrea scalrosa and ferruginea, are, it is believed, not found elsewhere.

On the Impregnation of Timber.*

BY DR. WARTH.

TIMBER consists of fibre and sap. The former is an organic combination of Carbon, Hydrogen and Oxygen. The latter is a mixture of water and colouring matter, fats, ethereal oils, resins, tannin, gum, mucus, starch, sugar, organic and inorganic salts, and albuminous substances.

Timber is liable to destruction by insects and by decomposition. The decomposition of the sap commences first and the sap communicates the decomposition to the fibre. The fibre itself is however not free from the liability to decomposition. In damp air chemically pure fibre decomposes. When linen or cotton cloth is bleached, the colouring substances are first oxidised with a small amount of the fibre, which is the same fibre as that of wood. After the colouring matter has been destroyed and nothing is left but the pure fibre, the latter commences to decompose, and unless the bleaching process were stopped the cloth would be wholly ruined. Hemp fibre is nearly pure and yet hempen ropes have to be protected against wet by means of tar. Thus it is clear from these examples that, even supposing the sap to have been removed or rendered harmless, the woody fibre itself if not protected is still liable to decomposition, although of course in a much smaller degree than when full of decomposing sap.

Damp with simultaneous access of air is most injurious to the wood as it promotes decomposition.

Precautions are taken when felling the timber that it should contain as little sap as possible. In parts of Europe timber is felled in winter and the trees are allowed to lie for some time with the branches and leaves on them, so that the budding which

* Part of this paper was read at the Simla Conference in October 1875.

takes place the following spring will exhaust the fluid remaining in the stem. For a similar purpose peeling off the bark of the living tree some time before felling has been recommended.

After the timber has been felled it has to be seasoned. During the seasoning process some substances contained in the wood not only lose their water, but also in a great measure their hygroscopic property. If after once having been dried or seasoned the wood becomes wet again it dries much sooner. Wood has also been seasoned by artificial heat. This process is sometimes very useful, but it requires care; otherwise the wood will crack and split. The seasoning by artificial heat has been adopted in connection with impregnation. Wood is not only mechanically injured, but actually decomposed at a temperature of 300°.

If after seasoning the wood is protected from moisture it will of course remain unaltered for a considerable time and a superficial coating is all that is required to render it still less liable to decomposition. It is wood exposed to the open air and to all atmospheric changes which requires special protection, and for the sake of which the system of impregnation has been introduced.

Railway sleepers are not only exposed to the rain and sun in succession, but they also have to lie on the ground from which they imbibe moisture To protect them in some measure care is taken that they are bedded in a good ballast which allows the rain-water to drain off quickly and decreases the absorption of moisture from below.

Coatings should of course only be applied to well seasoned wood, and it is unnecessary to explain that green or wet wood when coated over will not be able to dry and must therefore soon perish. A completely air-tight coating would preserve the wood for ever against any influence; but this is not possible. Wood has been boiled in tallow to give it an impervious coating; but it was a failure. Boiled coal-tar, free from ammonia, forms a very valuable protection to the wood. The coating of coal-tar can be repeated until the tar has penetrated the surface of the wood to the depth of half an inch. A very good substance for coating timber is also a solution of resin in linseed oil. Silicate of soda gives also a good protection.

A mere surface coating of the wood is also a good external protection. It prevents decomposition commencing from the outside.

In many cases superficial coatings are used with effect for keeping off white ants. In Burma, for instance, the timber of wooden structures is coated with petroleum as a protection against white ants, but the process has to be repeated every year. The ends of wooden rafters have been dipped into coal-tar and the access of white ants from the walls to the rafters has thereby been prevented. A coating composed of vegetable extract called "gutta gambier" with dammar oil and lime has been found effective against white ants. Painting the wood with a solution of sulphate of copper has also been practised.

To protect wood which has to withstand wind and weather something more than mere seasoning and coating is required. It must be altered constitutionally. This is done in two ways: by the removal of the sap, and by the addition to the wood of a new integral part in the shape of an antiseptic substance. As the antiseptic substance as a rule is capable of combining with the albumen of the sap, thus rendering the latter harmless, the expulsion of the sap can in most cases be dispensed with. There is one method which will be specially explained hereafter, where the expulsion of the sap and the addition of the antiseptic substance take place simultaneously.

Independently of this latter method the sap may be expelled by various means. Wood will lose a great part of its sap by long continued soaking in stagnant or still better running water. Steaming is a quicker process, but not much resorted to, because the wood is found to deteriorate. Heating the wood by means of dry air is preferred to steaming. This does not remove the solid contents of the sap, but it renders them less dangerous, because the albumen is coagulated by the high temperature. Albumen coagulates at 167°.

Antiseptic substances are also necessary for the preservation of the fibre even after the sap has been rendered harmless; because, as has been already explained, the fibre is in itself subject to decomposition. The following substances have been used or proposed for impregnation:—

Creosote of commerce which is made from coal-tar.
Carbolic acid in an alkaline solution.
Raw wood creosote.
Raw acetate of iron.
Sulphate of copper.
Chloride of zinc.
Sulphate of zinc.
Perchloride of mercury or corrosive sublimate.
Chloride of sodium or common salt.
Sulphate of soda, saltpetre, borax.
Sulphate of iron, arsenic.

The creosote of commerce and the raw wood creosote are oily substances and are used by themselves, whilst all the rest of the above substances are used in aqueous solutions.

The creosote of chemists is procured by the distillation of wood, and it is also contained in wood-smoke. A substance very similar to the genuine creosote is contained in coal-tar and this latter substance in its pure state is the so-called carbolic acid.

Genuine creosote is at ordinary temperatures a fluid, whilst carbolic acid is a solid. Carbolic acid exists as an article of commerce not only in a crystalline state of comparative purity, but also in a fluid state, being kept in solution by various tar oils. This fluid mixture of tar oils and carbolic acid is the creosote of commerce. It is not strictly correct to call it creosote, because the name of creosote was originally given to the antiseptic substance of the wood-tar only, but as the name is generally applied it is not expedient to make an exception here. The simple term creosote is therefore used in referring to the product of coal-tar, whilst if the product obtained from wood-tar is spoken of, the expression "genuine creosote" or "wood creosote" is made use of.

The two substances, wood creosote and carbolic acid, resemble each other so much that for many years their identity has been maintained. There are however re-actions which clearly mark them as different substances. While carbolic acid is solid at ordinary temperatures, wood creosote has only been obtained in a solid state at a temperature below freezing point. Further,

the wood creosote has the characteristic smell of wood smoke, whilst carbolic acid has a different smell. Wood creosote boils at 397°, whilst carbolic acid boils at 369°. The density of both substances is slightly above that of water. Both are little soluble in water, but mix in all proportions with alcohol and ether. Both coagulate albumen readily, a fact which explains to some extent their preserving properties. Both combine readily with alkalies, and in the case of both substances this property is made use of in separating them from other more neutral oils of wood- and coal-tars. Carbolic acid has also been combined with alkali for the purpose of preparing an aqueous solution for the impregnation of wood.

The dry distillation of wood yields, besides charcoal and gas, a heavy tar, and floating above the tar, an aqueous solution of acetic acid and of other substances.

This solution used to be called raw pyroligneous acid. This acid, when purified, proves however to be identical with acetic acid. The raw acid contains much wood spirit and 1 per cent of creosote. The impure acid in combination with iron is used for the impregnation of wood. This is what is meant by the raw acetate of iron enumerated amongst the antiseptic substances. The tar is distilled a second time when oils, first lighter, then heavier, than water are separated from the pitch. The heavier oils represent the raw wood creosote. For chemical purposes pure wood creosote is prepared from this raw material by repeated distillations, combination of the wood creosote with alkali, redecomposition with sulphuric acid, etc.

Coal yields besides coke and gas also a watery and an oily fluid. The former contains principally ammonia, the latter is subjected again to distillation. First more volatile oils are distilled and with them benzine. At a temperature ranging between 150° and 200° the oils containing carbolic acid are distilled. The mixture of these latter oils and the carbolic acid constitutes the raw creosote of commerce. For the purpose of obtaining chemically pure carbolic acid repeated distillations are carried on, during which the carbolic acid is combined with lime and separated by muriatic acid and then again combined with oxide of lead and set free by muriatic acid, etc.

The dry distillation of wood yields products in something like the following proportions, which, however, vary considerably with the method employed :—

Charcoal	...	25	per cent.
Wood-tar	...	7	„
Water with acetic acid, etc.	...	50	„
Gas	...	12	„
Loss	...	6	„
Total	...	100	per cent.

Pines and firs being more resinous yield up to 14 per cent. of tar.

Wood-tar re-distilled yields half of its quantity in pitch and half in volatile substances. The volatile substances consist to a great extent of creosote. The quantity of raw creosote in the wood-tar is on an average equal to 3 per cent. of the wood originally employed, and the quantity of pure wood creosote in the wood-tar is on an average equal to at least 1 per cent. of the wood originally employed. The raw acetic acid also contains 1 per cent. of wood creosote. To make a solution of raw acetate of iron, old iron is thrown into the raw acetic acid, in which a sufficient quantity of the iron dissolves to neutralise all the acid. The solution of raw acetic acid is used for the impregnation of timber chiefly on account of the creosote it contains. Thus two kinds of material for impregnation are obtained from the dry distillation of wood—(1) the oily substance with much creosote; (2) the watery solution of acetate of iron with a small proportion of creosote. The latter material has not yet been generally approved of as a powerful antiseptic.

During the manufacture of gas from coal the following products are obtained :—

Coke	...	70	per cent.
Tar	...	6	„
Ammoniacal liquid	...	6	„
Gas	...	12	„
Loss	...	6	„
Total	...	100	per cent.

The specific gravity of coal-tar is 1·016. When re-distilled it yields 25 per cent. of volatile oils, which can again be separated into lighter and heavier products. The former contain benzine, the latter contain carbolic acid, and they constitute the raw creosote of commerce. The quantity of pure carbolic acid contained in the whole of the tar is not less than 3 per cent. The quantity of carbolic acid in the creosote of commerce is sometimes very small indeed. For purposes of impregnation the proportion of carbolic acid ought to be not less than 8 or 10 per cent.

Creosote can be tested as to the proportion of carbolic acid it contains by a very simple process. The creosote is placed in a graduated glass tube. Solution of caustic alkali of a strength of 10 per cent. is added and the whole well shaken and afterwards allowed to settle. At the bottom unaltered alkali solution will be found, above this a syrup like combination of carbolic acid with the alkali, and last the undecomposed volatile oils. The diminution of volume which the volatile oils have suffered indicates the quantity of carbolic acid.

Peat and lignite yield similar products to those of wood and coal. Peat gives about 7 per cent. of tar and 30 per cent. of ammoniacal water. Lignite gives about 7 per cent. of tar and 40 per cent. of ammoniacal water. These tars contain large quantities of either creosote or carbolic acid.

Oil from bituminous shales contains also a substance similar to, although not quite identical with, either wood creosote or carbolic acid.

Petroleum has been proposed as a substance for impregnating wood with. No results of experiments are however known.

Creosote of commerce is the most important substance for the impregnation of wood. Not only is the carbolic acid which it contains a most powerful antiseptic, but the tar oils also which keep the carbolic acid in solution are a most valuable protection of the woody fibre against damp. Creosote is also cheap and procurable in large quantities, so that it is well adapted for use on a large scale. The carbolic acid of creosote has also been made use of for preserving bones and skins which are exported from Australia, Buenos Ayres and Chili. Further it is used for

disinfection and for many other purposes, which go far to prove its excellent antiseptic qualities.

Carbolic acid has been used in combination with alkali in aqueous solution as a substance for impregnation. After the first impregnation with the carbolic acid salt the wood has been saturated with a solution of sulphate of iron. This has the effect of causing free oxide of iron to be deposited in the pores of the wood and of setting the carbolic acid free from the alkali. This material has the advantage that it can be used with water, but it is certainly a pity to lose the services of the tar oils, which accompany the carbolic acid in the creosote.

The raw wood creosote as an antiseptic for the preservation of wood is in no way inferior to the creosote of commerce. On the contrary, the raw wood creosote contains much more really antiseptic substances than the creosote of commerce does. It is however very expensive and scarcely procurable in quantities large enough for purposes of impregnation.

Raw acetate of iron can be used in aqueous solution and this solution is able to take up a large proportion of wood creosote, which latter may thus be brought into the wood simultaneously with the iron salt. This substance is costly and the results are questionable.

The antiseptic qualities of sulphate of copper have been proved beyond a doubt and it is very extensively used. There are instances when the impregnation of wood with sulphate of copper has failed. It is however unfair to ascribe all failures to the substance itself. Mineral salts when used as antiseptics have deficiencies from which creosote is free, but otherwise sulphate of copper is a good material. Sulphate of copper is used in solutions with 1 to 2 per cent. of the salt.

Chloride of zinc is a good antiseptic for the impregnation of wood. It is, however, not quite so good as sulphate of copper, but it is cheap and on that account not less important than the copper salt. The impregnation with chloride of zinc offers the advantage that the wood does not become hard and can be dressed after the impregnation. Wood impregnated with chloride of zinc will also take coatings of oil paint.

Sulphate of zinc would no doubt be as efficacious as chloride of zinc, but it is not employed owing to its being more expensive than chloride of zinc.

The perchloride of mercury or corrosive sublimate has the disadvantage of being extremely poisonous and very costly. Its antiseptic qualities are indisputable. It is used for the preservation of specimens of natural history, pictures, &c. It coagulates albumen most readily. The solution which is used for impregnation contains 1 per cent. of the salt or even less. Kyan introduced the use of corrosive sublimate. The process is called after him the "Kyanizing process." Corrosive sublimate is not much used, owing to its being more costly than other antiseptic substances.

Common salt is well known to have the property of preserving organic substances from decomposition. It has been found that timber in salt mines keeps remarkably well. The timbers of ships loaded with salt fish remain in a good state of preservation. There is also a custom called the salting of ships, the salt being strewn between the inner and outer planking of the ships to preserve the wood below the waterline. Sleepers have been preserved on the Magdeburg and Leipzig railway by throwing waste salt from the neighbouring saltworks over them. This salt was carried in the shape of brine into the sleepers when it rained. Of course, the salt had to be often renewed. When salt is employed it must be used in sufficient quantity to prevent its being washed away. Salt is a very good preservative in damp places. When used in too small quantities salt will have only the effect of attracting moisture without protecting the wood. Salt has been repeatedly recommended for impregnating purposes, but applications of it for railway sleepers are rare.

Sulphate of soda is known also as an antiseptic substance. In India it is known under the name of "kari" and used for the preservation of raw hides before they reach the tanneries. Sulphate of soda has not yet been used for the impregnation of wood. It might be of some interest to know what result sulphate of soda would yield because "kari" is cheap in India.

Saltpetre is a similar material, which could easily be obtain-

ed in India. Saltpetre is antiseptic, but no results with it as a material for impregnating wood have been made known.

Borax has only been lately proposed.

Sulphate of iron has been tried in some cases, but is no longer used, other metallic salts having been proved to be superior. Sulphate of iron has the effect of hardening wood.

Arsenic was used for the impregnation of sleepers in 1840, in England. It proved effective in the case which is on record, but its use has died out.

A kind of petrifaction of wood has been produced by a successive impregnation with two different solutions; these solutions being so chosen that they will form a precipitate when mixed. This precipitate remains as an insoluble, in fact stony, substance, and as it were petrifies the wood. At first sight it would appear that this process might add to the durability of wood, but in actual practice it resulted in nothing and has been entirely abandoned. The stony particles massed in the minute cavities of the wood have no chemical action on the woody fibre nor can they protect it from moisture. The damp enters the wood almost as freely as if foreign bodies were not present, because these foreign bodies can only partially fill the cavities.

The combinations of solutions which have been tried are :—

Alum and alkali.
Silicate of potash and sulphuric acid.
Chloride of barium and sulphate of iron.
Chloride of barium and carbonate of soda.
Chloride of calcium and sulphate of soda.
Tin or copper salts and alkali.
Sulphate of iron and carbonate of soda.

Having enumerated the antiseptic substances with which wood is impregnated, it remains to describe the various processes by which the impregnation is performed.

They are :—First, the impregnation of wood with vaporous substances; second, the impregnation with fluids.

The impregnation of wood with vaporous substances, if practicable, would have very great advantages over the impregnation, with fluids. Mr. Molesworth therefore has urged the ex-

pediency of making experiments on a large scale with vapour of an antiseptic substance. The natural process of impregnation is that with smoke. Wood smoke, containing creosote, when acting a long time on wood, renders the wood exceedingly durable. Open woodfires in huts preserve the timber and straw of the roofs, and are known to preserve from decay even new hay and corn when stored in an insufficiently dry state under the roof. A Frenchman named Moll obtained a patent in 1855 for impregnating wood by exposing it in a closed chamber to the vapour of creosote. In Vienna, a man named Paradies, claims to have been successful with the vapour of tar.

A difficulty appears to lie in the high temperature at which carbolic acid boils, namely, 369°. Genuine wood creosote requires even as much as 397°. Wood itself commences to decompose, when subjected to a temperature higher than 300°. The creosote must therefore be largely mixed with other vapours and gases to render it volatile at a temperature which is not injurious to the wood.

Four different processes are made use of for impregnating wood with liquids :—

1. Spontaneous ascent of the antiseptic fluid in the stem of the living tree, sometimes aided by pressure.

2. Replacement of the sap in felled stems by the antiseptic fluid under hydraulic pressure.

3. Soaking of the wood in the cold or boiling antiseptic fluid.

4. The pneumatic process. Exhaustion of the air from the wood in a boiler, and application of high pressure to force the fluid into the wood.

The spontaneous ascent of the antiseptic fluid in the stem of the living tree was tried in Germany by Oberförster Biermann and Dr. Brandis. It was carried on in the following way :—

A hole was bored into the stem at the base, and through a tube, which was connected with a cask full of antiseptic fluid, the latter was allowed to flow into the hole. The tree at once commenced to drink up the fluid. The constant evaporation of water by the leaves causes under ordinary circumstances the rising of water from the roots up into the stem and branches.

The antiseptic fluid being however offered much more readily than the water supplied by the roots, and as a precaution some of the roots being cut through, the antiseptic fluid alone rises in the stem and spreads during fair weather within 24 hours over the whole tree, which, being thus impregnated with sulphate of copper or chloride of zinc, dies in a few days.

A similar process was tried by Uzielli, who used the following antiseptic substances :—

Raw pyrolignite (acetate) of iron or copper.

Common salt.

White arsenic.

Solution of resin in oil of turpentine or alcohol.

A drawback to this process is the necessity of impregnating the whole tree, and the waste of antiseptic fluid arising therefrom. This would however not matter so much ; because we have a very cheap material—the chloride of zinc. A more serious obstacle may be the difficulty of floating the timber after the impregnation. This may have been one reason, why this process, which is exceedingly simple, and at the same time most perfect, has not hitherto been employed in India.

2. Replacement of the sap in felled stems by the antiseptic fluid under hydraulic pressure. (Boucherie's process.)

Newly felled logs are laid horizontally and one end is fitted up in such a way that the antiseptic fluid can be brought to bear upon the wood under a hydraulic pressure of a column of water 30 feet high. The stems have the bark on them, and the fluid enters the stem and flows towards the other end. As soon as the antiseptic fluid commences to enter at one end the sap of the tree exudes at the other end, and is gradually expelled, the antiseptic fluid taking its place. Moderate sized trees yield several tons of expelled sap. At first the issuing fluid is pure sap, but after some time a mixture of sap and antiseptic fluid takes place in the interior of the stem, and the two fluids issue together. However by continuing the admission of antiseptic fluid the sap is made more and more to disappear. The result is considered satisfactory, when the last fluid, which issues from the tree, contains only one-third of sap and two-thirds of antiseptic fluid.

The antiseptic substance exclusively used in this process is sulphate of copper. It is employed in a weak solution containing 1 per cent. of salt. Success in this system very much depends upon the kind of wood. The process answers very well with beech, it also does for pine, but oak is entirely unsuitable. The antiseptic fluid cannot pass through the hard old wood of the oak. Instead of laying the stems horizontally, they have also been placed upright, and the fluid was made to enter from above. No oily substance like creosote could be used with this process.

3. The mere soaking of the wood although very convenient is of course as a rule a most imperfect process ; still there are cases, where soaking is resorted to with some success. Soaking is fairly illustrated by experiments made at the Calcutta Mint. Some sleepers were immersed in tar for a period not less than 60 days, and yet they showed scarcely any penetration. Chloride of zinc in solution has been applied to wood by means of soaking, but it was afterwards found necessary to adopt a more perfect process (which is described below). The timber used to be immersed two days for every inch in thickness, and after the soaking was left to dry for 14 to 19 days. Soaking with sulphate of copper was found not to answer well. In the above process a great deal depends on the wood; very light wood well dried in the air, or artificially dried, takes up fluid readily.

Heating the fluid also lends further aid to the impregnation. Thus in one instance wood was artificially dried, and whilst hot was immersed in hot creosote, when it absorbed as much as 8 or 9 pounds of creosote per cubic foot. Further, on a certain German Railway, sleepers were immersed for 4 hours in creosote raised to a temperature of 150°. The impregnation was considered fairly satisfactory for such a cheap method. Boiling of sleepers with steam in a solution of metallic salt has not been found to answer. It may be expected that mere soaking succeeds best when the quantity of antiseptic substance is limited. This is the case when perchloride of mercury or corrosive sublimate is used. Corrosive sublimate is very dear, and impregnation has been practised by soaking the sleepers in a

solution of it from 1 to 10 days. The solution contained 1 per cent. of the salt or less, and only half an ounce of salt is expended on one cubic foot of impregnated wood.

4. The Pneumatic Process of Impregnation.

This is the most perfect process, and gives satisfaction when others fail. The following are the ordinary requirements of a pneumatic impregnating apparatus.

(1)—Two cylindrical boilers of 6 feet diameter capable of withstanding the pressure of the atmosphere during the evacuation of the air in them, and also of an interior pressure produced by a hydraulic pump worked up to 150lbs. per square inch.

(2)—An air pump to exhaust the air from the boilers.

(3)—A water pump.

(4)—An hydraulic force pump to supply the boilers with fluid up to a pressure of 150lbs. per square inch.

(5)—An engine of about 10-horse powers to work the pump.

(6)—Reservoirs for the antiseptic fluid, &c.

(7)—Tramways to bring the wood on waggons to and from the boilers: the wagons being of such shape that they can be run into the boilers, which are provided with rails and large top-pieces for the purpose.

There is nothing particular about these requirements, which can all be obtained without difficulty. The boilers differ in nothing but their top-pieces from the ordinary steam-boilers; and the air and water pumps are the same as those manufactured for other purposes. Any engine will do, or a water-wheel, if there should be sufficient water-power available. The tramways, reservoirs, &c., may be constructed as most convenient in each case, so no description of them is necessary.

The Pneumatic Process. The wood is brought to the apparatus in its finished state, it is packed on the wagons, and with them pushed into the impregnation-boiler, and then the lid is closed and made air-tight. If steaming is to take place it is done now before further operations. Steaming of course is only suitable when aqueous solutions are used for impregnation, and when the wood is not already well seasoned; it would never do to steam the wood before

the impregnation with oily creosote. The creosote and the oils would fix the water in the wood. If creosote is the substance with which the wood is to be impregnated, the wood may, with advantage, be subjected to artificial dry heat. After the steaming up to 150°, the liquid must be drawn off which has collected on the bottom of the boiler. When all fluid has left the boiler, the exhaustion of the air, by means of the air-pump, is commenced. The minimum of pressure is reached after half an hour's pumping, but the work has to be continued as the wood does not give up its air all at once.

After the exhaustion of the air, the impregnating fluid is admitted. Creosote is often used in a warm state of 100 to 120 degrees temperature so as to render it more liquid. Whilst the fluid is forced in by superior pressure of the atmosphere, the air-pump must still continue playing, otherwise the rarified air in the boiler would, by being limited to a smaller and smaller space gradually, become denser, and would fill the uppermost pieces of timber, rendering them thus incapable of receiving the impregnating fluid like the other timbers.

Care must be taken to avoid overfilling the boiler, because otherwise the antiseptic fluid would get into the air pump. When the boiler is very nearly full the access of the fluid is stopped, but the air pump is worked for a short period longer. After this the air pump is stopped, and the compression of the antiseptic fluid in the boiler commences. The force-pump drives more and more fluid into the boiler until a pressure of 120 pounds, sometimes of 150 pounds, per square inch is reached. This pressure is kept up for a time, varying from 2 to 16 hours, during which time the wood constantly imbibes fluid. The process is finished up by running the fluid off, opening the head-piece of the boiler, and taking the wagons out.

The completeness of the impregnation depends in a great measure upon the length of time during which the pressure is maintained. As a rule, the time allowed for the various operations is such that the boilers can be filled twice every working day.

The pneumatic process is adopted both for creosote and for

metallic salts. As regards the sulphate of copper it is however to be remembered that a solution of sulphate of copper cannot be brought into the iron boiler. Factories where sulphate of copper is used must therefore be provided with costly boilers made of copper.

When creosote is the antiseptic substance employed the amount taken up by pine and other soft woods is 10 to 12 pounds per cubic foot. This amount is considered to be sufficient, and even a smaller quantity of creosote would answer in many cases. Hard woods take up much less creosote. Oak, for instance, takes up only 2 or 3 pounds of the oil, even under the heaviest pressure possible. Indian sal wood was found to be penetrated only to $\frac{1}{8}$th of an inch from the surface during one particular trial. Sapwood is easier penetrated than old wood, in which the circulation of the sap had ceased before the felling of the tree. There need be no hesitation as regards the use of impregnated sapwood. If well impregnated it is often found superior to heartwood, which has taken up an insufficient quantity of creosote. Examples of woods admitting easy and perfect impregnation are: Maple, alder, beech, plane, birch, lime-tree. Not quite so easy are the following: Pine, fir, larch, poplar, elm. The oak and acacia are scarcely suited for impregnation.

The following experiments show what amount of creosote some of the harder Indian woods were found to take up :—

	Pounds of creosote per cubic foot.		Pounds of creosote per cubic foot.
Sissú ...	... $3\frac{3}{4}$	Sàl ...	... 1
Sundri ...	... $2\frac{1}{4}$	Ironwood	... 1
Teak ...	... $1\frac{3}{4}$	Mahogany	... $0\frac{3}{4}$
Swan-river wood (Australia)	... $1\frac{3}{4}$	Jaman ...	... $0\frac{3}{4}$

Experiments with aqueous solution of chloride of zinc go to corroborate the results which were obtained from creosote, the hard wood taking up much less than the soft wood. The following table shows the quantity of solution of chloride of zinc taken up under the pneumatic treatment by different kinds of wood :—

1 cubic foot of	pine wood	...	16 lbs. solution.
1 ,,	beech	...	18 ,, ,,
1 ,,	oak	...	8 ,, ,,

The small capability of some hard woods to take up antiseptic fluids matters little as long as these hard woods are able to endure as long unimpregnated. This is more or less the case with oak in Europe and with sál and teak in India. Sál and teak, as also deodar, are used unimpregnated for sleepers in India. The class of woods which require impregnation are pines (*Pinus longifolia, P. excelsa, Abies Smithiana*) which are capable of taking up a full quantity of creosote or other antiseptic fluid. These light and less valuable timbers can thus be impregnated and rendered as durable as the superior deodar, sál and teak.

It remains to decide what method of impregnation should be adopted in India for railway sleepers. We find that of all the methods enumerated only three have to be considered. These three are the following:—

1. Creosoting, that is, the impregnation with common creosote by means of the pneumatic process.

2. The method of introducing a solution of sulphate of copper by means of replacement of the sap in felled stems.

3. The method of introducing a solution of chloride of zinc with the pneumatic process.

A fourth method: soaking the wood in a solution of corrosive sublimate comes next to the above three in importance, but the material is too expensive.

Among the above three methods creosoting stands foremost. Mr. Molesworth says:

"I cannot recommend that impregnation by sulphate of copper, chloride of zinc, or other chemical mixtures should be adopted. I have invariably found them to fail, and at all events the impregnation by such fluids has not been brought to sufficient perfection to commend itself to general use."

Creosote is undoubtedly the first of the substances used for impregnation. It is the best antiseptic, and it increases rather than diminishes the strength of soft wood, its effect being thus contrary to that of metallic salts. It also resists more than other substances the lixiviating action of the water. Creosote, when used with the pneumatic process, doubles the durability of soft woods, and there is no risk of failures. Creosote also

keeps off white ants. Creosoted sleepers are admirably fitted for India.

The method of sap-replacement by means of sulphate of copper solution would not be generally applicable in India; because the wood has to be floated, and takes a long time in reaching its destination. The use of chloride of zinc has the disadvantage of rapidly corroding iron, and consequently the nails soon become loose in sleepers impregnated with this substance. Yet this salt would be the one to be substituted in the absence of creosote. The pneumatic process is undoubtedly the most advantageous process.

In England the pneumatic process with creosote is almost exclusively applied. The Cologne—Minden, and Rhine Railway, and several other German Railways also use creosote. Creosoted sleepers have also been successfully used in India.

The impregnation with sulphate of copper by the process of sap-replacement was first introduced on a large scale in France, and lately Austrian Railways have taken up the same method. In Upper Italy, blue vitriol has been used to impregnate beech wood by means of the pneumatic process. In Bavaria sulphate of copper is also employed. In Brunswick and Hanover impregnation with chloride of zinc is carried on by means of the pneumatic process; whilst perchloride of mercury is made use of in Nassau and Baden.

In 1873, a Mr. R. D. Tander, (patentee of the Indo-American Wood-preserving Substance), applied for some sample sleepers in order to try how much creosote they would absorb. Samples were sent, but no report has been received.

The following examples may give a general idea of the cost of impregnating machines adapted to the pneumatic process:—

In India.—

A machine was once offered for sale at Phillour for	£1,175	0 0
The E. I. Railway machinery used at Alligurh, cost at Calcutta	£1,750	0 0
The E. I. Railway machinery at Bareilly used in 1874, for creosoting chil-sleepers, cost ...	£2,200	0 0
The large machinery at Sahibgunge ...	£3,000	0 0

In Europe.—

A machinery with 2 boilers at Brunswick ...	£2,800 0 0
Do. do. at Hildesheim in Hanover ...	£1,500 0 0
Do. do. with 2 copper boilers for impregnation with sulphate of copper only ...	£2,500 0 0
Do. do. of the Cologne—Minden Railway	£3,300 0 0

The price of the substances used for impregnation naturally varies considerably. The following European prices are therefore to be taken only as approximate, and intended to give a general idea of the cost of antiseptics used for impregnation.

Prices per ton in Europe.

	£	*s.*	*d.*
Creosote...	4	0	0
Chloride of zinc	10	0	0
Sulphate of copper	50	0	0
Perchloride of mercury	500	0	0

The total cost of impregnation varies even more than the price of the materials. The following data will give some idea of the cost of impregnating pine wood :—

	£	*s.*	*d.*
Creosote by the pneumatic process, per c. f. ...	0	0	4
Chloride of zinc do. do. do. ...	0	0	2
Sulphate of copper by sap-replacement, per c. f.	0	0	4
Perchloride of mercury by soaking only, do.	0	0	4

The cost of creosoting sleepers in India depends entirely upon the rate at which creosote can be imported from England, as there is at present no material with which to replace English creosote. Ship-owners dislike creosote as a cargo, for it necessitates the exclusion of other goods from the hold. The same objection, however, applies to the shipping of creosoted sleepers from England. From Calcutta to a place so far from the coast as Lahore the railway freight is 95*s.* per ton. A ton of creosote imported from England to Calcutta costs say £5, and the same would cost in Lahore about £10.

At Lahore the cost of the English creosote, necessary for impregnating a sleeper of 3½ cubic feet, would thus be 3*s.* 2*d.* If we add the cost of labour and apparatus we may assume 3*s.* 6*d.*,

as the cost of creosoting one Indian sleeper at Lahore with English creosote. Creosoted pine sleepers can be imported from England to India (Calcutta) at 7*s*. 3*d*. per sleeper. From Calcutta to Lahore the railway freight would be 4*s*. per sleeper. Thus the cost of one creosoted pine sleeper, landed at Lahore from England, would be 11*s*. 3*d*. This would be more expensive than Indian sleepers creosoted at Lahore with imported creosote. Mr. Molesworth has found that at Agra imported creosoted sleepers are cheaper than Indian sleepers creosoted at Agra. At Delhi, imported creosoted sleepers. and Indian sleepers creosoted at Delhi have been found to be equal in cost. As we go farther north, the difference in cost becomes greater in favour of Indian creosoted sleepers. It is clear that sleepers of inferior Indian pines might with advantage be impregnated with creosote from England for the Punjab Northern State Railway. The English creosoted sleepers could not compete in the northern parts of the Punjab with sleepers creosoted in India.

Far more desirable would it be if Indian sleepers could be creosoted with some material procurable in the country. There are, however, no data at present to show whether any substance can be obtained cheap enough to compete with creosote imported from England. In Calcutta the coal-tar from the gas works is sold at the exceedingly high price of 90*s*. per ton. This is almost as much as the price of English creosote sold at Calcutta, and besides this high price, only about 25 per cent. of the Calcutta coal-tar would be efficacious for impregnation.

The use of Burmese earth-oil has been suggested, but there are no data at all to show whether earth-oil would act as a sufficiently good preservative, nor would the Burmese earth-oil be much cheaper than creosote from England.

The products of distillation from wood might be used instead of coal-tar oil, but they are very expensive. Only at places far distant from any sea port they might possibly compete with English creosote. As above stated a ton of English imported creosote costs at Lahore, £10. As this is the rate at which good wood-tar was procurable in Europe some years ago, it seems not altogether impossible that wood-tar could be manufactured in this country at the same price.

Wood-tar oil might even be dearer than creosote and still compete with the creosote, because the produce of the wood contains more of the valuable real antiseptic substance, than the produce of coal does. For the same reason wood-tar oil would be an excellent material to mix with English creosote. The question of the manufacture of wood-creosote in India recommends itself as a subject of special enquiry. This much, however, is certain that it is highly advisable to creosote in India sleepers from inferior Indian woods, wherever there is not an abundance of superior woods, and where, at the same time, the distance from the coast prevents the importation of creosoted sleepers *from England.*

Technical terms.

ALL technical terms hitherto employed are literal translations of either French or German words, and one would, therefore, suppose that the best definitions would invariably be such as are accepted by authors of standard French and German books on Forestry. As some of Mr. Smythies' definitions do not, in my opinion, answer to those given by eminent continental foresters, I beg to be allowed to make a few remarks on this subject before our Forest Terminology is finally settled.

One thing, I think, we should carefully avoid, and that is the introduction of literal translations—as, for instance, *high forest*—of terms which foreigners, themselves, acknowledge to be most inappropriate.

It is difficult to exaggerate the importance of good terminology and good definitions. We know the importance men of science attach to a strict use of scientific terms, and the confusion which has often been occasioned by employing them in a loose way. We need not look beyond our own department for an example of the evil of careless nomenclature A considerable time seems to have elapsed between the creation of the so-called *survey division* and the discovery that surveying was only one of the least important of its numerous duties,*

* See a remark of Mr. Powell, in the proceedings of the Forest Conference, 1873-74, p. 105.—J. B.

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* See a remark of Mr. Powell, in the proceedings of the Forest Conference, 1873-74, p. 105.—J. B.

a mistake which could have been much less likely to have arisen, if that division had not been most improperly styled *survey division.*

I will now proceed to review a few of the technical terms and definitions proposed in Mr. Smythies' paper, and afterwards submit one or two others for the consideration of the readers of the *Forester.*

I.

Working-plan.

As I understand this word, it corresponds to the French term *projet d'amenagement*, and not to the *plan d'exploitation.* It is evidently derived from the German *Wirthschaft's plan* or *Betriebs plan*, of which the exploitation-plan forms only a part. Any one, who will compare a French with a German book on the subject, will certainly find that *Wirthschaft's plan*, or working-plan, corresponds to *projet d'amenagement*, and *Hauungs plan*, or felling plan, to *plan d'exploitation.* The working plan is, in fact, a recapitulation of the most important data collected during the organization of a forest, and contains a description of its state, area, sub-division, reasons for adopting the revolution chosen, data on which the supposed yield is based, felling or exploitation-plan, regeneration-plan and other minor matters. I propose, therefore, to employ the term *working-plan* in the latter sense, and

Exploitation-plan

as corresponding to the *plan d'exploitation* of the French Forester, which consists in a tabular statement of the portions of the forest to be cut and the yield of material during a period.

Working-circle

Corresponds to the German *Wirthschaftsbezirk.* In this sense, it would denote several groups of forest, or blocks, not necessarily continuous, but sufficiently large and compact to be placed under a senior executive officer, either a Deputy Conservator or Senior Assistant; the working-circle would generally coincide with some civil division of the province, probably one or more Deputy Commissionerships or Collectorates. The term Division appears to me synonymous and equally expressive.*

* The word "division" is already used to indicate an administrative forest charge, which is a thing entirely different from the area to which each special working plan applies, though the two may coincide in certain instances.—THE EDITOR.

Block.

(From the German *Bloch, Verband*) I would define as a tolerably compact forest, consisting of one or more *series*,* and so regular and similar as regards station, vegetation, etc., as to admit of one working-plan being made for the whole forest.

Compartment.

(*Fr. Division,* Gr., *Abtheilung*), is the smallest *permanent* sub-division of a forest, the sub-compartment being the smallest and distinguished from the former chiefly by its transient nature. It is, for example, usual to divide forests into compartments *of convenient size—50 to 100 acres—and, wherever* no well-defined boundary, such as a road or river, is available, to separate them by rides cutting each other, if possible, at right angles. The size and form of the sections thus formed depend on many considerations, such as the topography of the ground, species and their age-classes, station and so forth; but the number, size and shape of the sub-compartments of any compartment will depend entirely on the number, size and shape of the different groups of trees in such compartment, and one of the objects of the Organization-Department is gradually to give a uniform character to the whole and thus ultimately to do away with sub-compartments altogether; but the compartments, which are separated by strongly-marked natural features, cleared lines, or roads, are unchangeable.†

Rotation or Revolution.

There is no apparent reason for not retaining the French word *revolution,* more particularly as the word *rotation* is already used in quite a different sense by agriculturists—and consequently also by foresters—who use it to denote a change of species.

High Forest

Is a literal translation of the word *Hochwald,* a term which Germans themselves acknowledge to be most ill-chosen; in the

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* For an explanation of this word see page 52.—J. B.

† What Jangali Bulbul says is almost precisely, what we, on several occasions, have tried to impress on our colleagues. The compartment may be called the unity of working area, and a convenient size of it is of far greater importance, than natural boundaries, in fact roads are in most cases preferable.—THE EDITOR.

first place, because a hochwald is often destined to be cut down long before it has attained its full height, and in the second, because coppice, although allowed to grow into a high forest, is still coppice, because it has not been regenerated by seed. I propose, therefore, to employ the term *seedling-forest* to denote all forest raised directly from seed, in contradistinction to coppice, which is the result of the cutting or burning down of a forest.

Seedling-shoot.

Instead of this term, I would employ the word *coppice-shoot*, which is certainly much more expressive. *Seedling-shoot* is, moreover, scarcely a proper term, as it might be more correctly used to denote the shoots of trees raised directly from seed.

Leaf-canopy.

Would not *leaf-cover*, or simply *cover*, answer the purpose just as well as this rather farfetched word? There would be no difficulty in expressing the exact amount of cover which would be given in decimals, perfect cover being equal to one.

Mature tree.

I would apply the word *maturity* to trees in the same sense as it is used in reference to any other organism. Instead of giving it a different meaning we might use the term *exploitability* in a technical sense. In the ordinary acceptation of the word, a forest would be mature when its trees were capable of reproducing themselves by seed and as soon as their annual growth both in height and bulk had attained its maximum. If the definition decided on at the Simla Conference is accepted, it will not always be applicable, because frequently the increase in bulk of forest species (e. g. bamboos) is never, during the whole life of the plant, "of importance," no matter whether we regard the matter from a technical or physical point of view.

Leaf-tree.

This is scarcely a correct translation of the word *Laubholz*. *Laub* does not signify *leaf*; it is at least a collective term and would have been better rendered in English by *foliage*. The German forester probably first used the word in the sense of

shade-giving, rather than in the sense of *leaf-bearing*. Viewed in this light, the word as used in Germany is intelligible, as broad-leaved trees certainly ought to afford more shade than spike-leaved trees. But another much more serious objection to the use of the term *leaf-tree* is, that it cannot be correctly employed to distinguish broad-leaved trees from conifers, for a conifer is also a leaf-tree, and to employ the term to distinguish one class of trees from another is, therefore, absurd.

II.

The co-efficient of form

Is the fraction which, when multiplied by the height and the area of the base (*at breast height*) of a tree, gives its cubic contents. The words *reducing-factor* and *form-figure* have been sometimes used, but they are awkward and unenglish translations of the words *Reduktionsbruch* and *Formzahl*, and, I think, not nearly so expressive as that now proposed.

Series.

Blocks may be divided into several *series*, the aggregate annual cuttings in which give the amount required for a sustained yield. In the simplest case, a block would consist of one series with a yearly cutting equal to the capability of the block. It is not necessary that a portion of each series be cut yearly, nor that the series be equal, or of any particular size. A series is, as it were, a block within a block, but the series has not, like the block, a sustained yield. I am aware that this is not at all an expressive term, but I give it for want of a better. The French use the word in a similar sense, only their *série* always has a number of cuttings corresponding to the number of years in the revolution, and, therefore, a sustained annual yield. The term *cutting-line* has, I believe, been used in the sense of series.

The Ideal forest

Is one in which the gradation of age-classes is perfect, and which gives, for the station, the greatest conceivable sustained yield. The Germans and French use the term *normal forest*, which is inaccurate; firstly, because, strictly speaking, nothing in nature is abnormal, and, secondly, because the model-forest

is a phenomenon confined to the forester's brain, and therefore abnormal.

Timber.

All wood used in building or carpentry.

Barren wood.

All wood not *timber*. At present bamboos are, generally, neither classed as timber nor as fire wood. The proposed definition of timber would bring them under this category.

Fence.

When domestic animals or men, or both, are kept out of a forest, it is *in fence.*

Station.

A general term, expressive of the soil, climate and situation, or the three elements on which the productive power of the land depends.

These are all terms of frequent occurrence which would inevitably occur in every report on forest organization, and for this reason it would be as well to have their meaning settled at once.

JANGALI BULBUL.

III. NOTES AND QUERIES.

A fragment from a German writer on the reasons why the State should manage forests.*

(Interspersed with some notes.)

"THE principles on which forest science depends have been, even up to recent times, a standing difficulty with economists. Sylviculture and agriculture, which in some respects are closely connected, are governed by economic laws essentially different: principles having a firmly established application to the one, are only exceptionally applicable to the other. Those who urge that all agricultural lands should be in the hands of private individuals, are at the same time obliged to invoke the intervention of the State in the case of forests; and acknowledge the State's right of tutelage as superior even to the right of the proprietor. While they urge on the one hand that the State should dispose of all its culturable lands, they maintain on the other, that the public forests should always remain in its hands. And lastly, if it is desirable to see agricultural estates sub-divided up to a certain limit, it is preferable on the contrary to keep the forest estates as consolidated in extent as possible. I think that these exceptions are easily accounted for, and that they rest on a simple and general proposition of political economy; it is because other conditions being equal, forests represent a system of cultivation less intensive than that of other properties."

[Degree of intensity of cultivation is the amount of labor and money expended in a longer or shorter time, in proportion to the area. In agriculture *intensive* cultivation is the opposite of *extensive.* Garden cultivation is more intense than agricultural in most cases, and agricultural cultivation is more intense than forest cultivation. The more intense the cultivation the less is it suited to be conducted by the State. Private individuals can originate and carry out schemes at once, as the demand arises; they can quickly alter their plan of operations, transport at once their

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* Communicated. The note contains one or two assertions, of which we do not quite approve.—THE EDITOR.

products to the places where they are in demand for the moment with no hindrance or check. Government operations must proceed with a certain slowness and obedience to rules.*

It follows that while private individuals best occupy those spheres of production which demand rapid and unchecked action, the State best occupies those which demand the slow action of time, and which depend not on the momentary considerations of the immediate demand, but on a combination of considerations which often reach into the distant future, or extend to the indirect results of present action.]

"Forests, quite unlike agricultural property, are much better preserved by the State than by private owners. They demand comparatively a small amount of labor, and the operations necessary are uniform in character, so that the management of the State is not unsuited to their wants.

"The instructions which the Forest administration issue can only impart an apparent activity to the work, for it is impossible even for an intelligent forester to do much to hasten the growth of trees. It is only the lapse of time that can build up the forest capital; and it is because of this necessarily slow progress that the State is best fitted to manage forest estates. The treatment of forests for the production of high-timber is impossible to any one except the State; and consequently those forests are managed in the interests of society in general (*i.e.*, present and future), and not in the interest of immediate financial returns. Thus, for example, when the State forests are few in number, it becomes necessary that the surveillance over private forests, by reason of their climatic influence, should be more severe than when the State has a sufficient area of its own. The Government has the necessary right (by means of the principle of expropriation on payment of indemnity) of possessing itself of all forest lands, the preservation of which the interests of the public at large demand.

"The system of tenant-farming is never applicable to forests.

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* Ce qui dans toutes les industries donne à l'action individuelle une grande superiorité surl'action gouvernmentale, c'est l'e sprit de l'initiative qui la caractérisent.

" La mobilité des opérations, la multiplicité des transactions, la transformation des produits la rapidite de leur transport sur les points ou ils sont demandés, ne s'accomodent pas de la régularité et de la lenteur calculée des administrations publiques.—*J. Claré, Etudes. sur L'economic Forestière, p. 32.*

[When a farmer makes over his land to a tenant to cultivate, he delivers nothing into his hand but the land, which the tenant cannot injure beyond a certain point; the tenant provides his own capital, which is to produce the fruits which he is to reap.] "*If* a forest were to be so given over, *the proprietor would* himself furnish the whole of the capital which is to yield the profit, *viz.*, he gives up into the hands of the tenant the standing trees. The temptation to the tenant to trench on the capital itself (which he has not had to furnish as in the other case,) and overcut the forest, is great, and it would be difficult to check him. He would be given a surveillance so severe, as to be tantamount to a direct management by the proprietor himself. Moreover, for forests, farming out to a tenant has not the same advantage as in the case of arable lands, because, without any intervention of the tenant, the forest furnishes inevitably its quantum of available produce, which is immediately realizable.

"Accordingly as forests offer an exception to the general characteristics of productive estates, so they offer an exception *in their management, the State retaining* it in preference to private individuals."

(From W. Roscher, Ein National und Oekonomisches Hauptprincip der Forstwissenschaft. Leipzig, 1854.)

Action of Forests on Retention of Moisture.

"WHEN *Napoleon was taken to St. Helena, says* M. Blanqui, the English perceived it necessary to take possession of the Isle of Ascension which was nothing but an arid rock, with a scanty covering of a few cryptogamous plants. A company of 100 men was established here. In ten years this little garrison perseveringly formed plantations, and succeeded in creating a productive soil in the island, and caused a spring of water to be formed. The island was also abundantly supplied with vegetables. This is what plantation *did* on a *bare rock in the middle* of the ocean."

M. Jules Clavé asks (on this story being told), why go so

far for the proof of a phenomenon which is renewed daily under our eyes, and which every inhabitant of Paris can convince himself of without going beyond the Bois de Boulogne or the forest of Meudon? Let him take a walk after some days' rain, on the road to Chevreuse, bordered on the right hand by the forest of Meudon, on the left by cultivated lands. The quantity of water which has fallen, and the duration of the rainfall, are obviously the same on both sides of the road: nevertheless the ditch on the side of the road adjoining the forest will be still full of water coming from the infiltration through the forest soil; the ditch on the left contiguous to the naked culturable lands will be dry, the water having *at once run off. The ditch* on the left will, in fact, have in a *few hours* all the water, which it takes the ditch on the right several days to conduct to the valley below. (*Etudes, p.* 54.)

Goats in a Forest.

Here is a graphic but very true picture of what goats do in a forest: what a perfect description of our Punjab Salt Range, and I have no doubt of other places in India!

The description is of forest of Savoy on the upper mountain ranges.

"You can see here and there a few bushes, the remains of forest that once flourished, but they are now browsed down by cattle, or cut by the villagers as fast as they send forth fresh shoots, until exhausted nature refuses to continue any longer her labor of vegetation; then the bushes disappear altogether, being but a greyish stain on the denuded slope.

"Under such conditions it is not surprising that cattle-feeding should have become, in most places, the chief standby of rural economy. Unfortunately, it is not the herds of white and dun cows that one sees on the sides of the hills of the Jura or Switzerland, whose silver-sounding bells resound far down the valleys; it is almost exclusively sheep and goats that cover the rock, and it is their plaintive bleating that alone breaks the silence of these solitary wastes. The sheep and the goat tear up the herbage instead of biting it clean off. They throw

themselves greedily on all kinds of plants.* They devastate the forest, ruin pasture lands, and cause damage greater and more irremediable than all other cattle put together.

When they are very numerous, they ravage the country just as a flight of locusts would. They cleave the soil with their narrow pointed hoofs, render it thus more easily furrowed by the next rainfall, and thus promote the formation of ravines.

In the four departments of Var, L'Isere, the Hautes and Basses Alpes, these goats are estimated at 1,500,000 in number: but all do not belong actually to the inhabitants of the departments. Some really come from Piedmont and Provence. After having passed the winter on the plains, during summer they are taken to the mountains, where *for a consideration of* 50 *centimes per head, thy acquire the right of not leaving in their track any trace of vegetation.*

Within proper limits grazing is a precious resource to the mountains; carried to excess, it becomes a veritable scourge."

PUNJABI.

The Dye from the "Toon" flower.

A good yellow dye said to be used for silk dying and to be permanent, is obtained from the flower of the "toon" *(Cedrela toona.)*

The panicles of whitish flowers are in blossom in April and early May.

The dye stuff is produced by certain small glandular hypogynous discs *at the base of the stamens. It will be observed that* some of the flowers are prostemonous, *i. e.*, develope the stamens first, and others are poststemonous, *i. e.*, develope the pistil first: indeed, on examining a small cluster of "toon" flowers one sees a number of flowers with a developed pistil and ovary, in which the stamens are withered and abortive and *develope no colored discs;* the neighbouring flower has stamens and discs and an abortive pistil. The flowers are honey-scented, but it is said insects are not attracted by scent but by color. Can these

* When they do not eat them, they nevertheless bite or rather wrench them off. Any one who has seen a goat in a Deodar or pine forest will have noticed this.

discs be intended to attract insects which shake the stamens and thus disperse (or themselves carry away and deposit) the pollen which thus reaches the neighbouring developed pistil? If so, why are the discs at the bottom of the flower, and not conspicuous?

B. H. B. P.

China Blackwood.

SIR,—In your number for October 1875, Mr. Robertson, BOM.C.S., kindly offered to send me seeds of China Blackwood, if he knew my address. Will he kindly send some, 20 seers, if he can spare so much, to address as below.

Yours obediently,

B. H. BADEN-POWELL,

Conservator of Forests, Lahore.

Movements of Pine Leaves.

SIR,—I beg to forward an extract from "The Garden" of February 5th, 1876, regarding an observed curious movement of the leaves of *Abies Nordmanniana.* It would be interesting to know if any of your correspondents have observed any similar movements in our Indian conifers?

I am, Sir,

Yours

C. F. ELLIOTT.

"M. Chatin has lately called attention in the French Academy to some curious periodic movement in the leaves of *Abies Nordmanniana,* which are whitish on the lower, and dark green on the upper, surface. If the tree be observed early in the morning, or about sunset, the "ensemble" of the foliage seems uniformly whitish: whereas, in the course of the day, the green tint seems very general. This is found to result from an alteration in the position of the leaves, so that they present, now their upper, now their under-surface to the observer, and a diurnal position can thus be distinguished from a nocturnal one.

M. Chatin has been studying these movements, and promises some further details regarding them shortly."

On the Killing of Trees.

(*No. III., page* 315.)

As M. H. F. has not thought it worth while to answer the pointless remarks made by F. B. with his talk about lecture rooms and treatises on botany, perhaps an on-looker might do so.

M. H. F. gives a lucid explanation on the point asked, and though his statement with regard to scalariform tissue may want breadth, it must be remembered that the whole subject is by no means as clear as the dogmatic assertions of old writers make it out. We should strongly advise both F. B. and his botanical friend to look for light elsewhere, than in the authorities they quote so wrongheadedly, though even these respectable authors must feel uncomfortable in the mouth of a man who talks about "hyrocarbons" *sic.* Why not *hieroglyphics?* It reminds one of the story of the S. C. Police Officer who reported that the "renumeration" of certain members of his force was insufficient.

KAD-HANDI.

Reproduction of bamboos by seed.

IN 1872 I reported the supply of bamboos in my charge to be inexhaustible (by fair cutting, *bien entendu*), and such was my firm opinion. We are now only at 1876, and the supply is apparently exhausted. In 1872, what the natives call the "Inda," *i.e.*, the general seeding occurred. I was prepared, by general report, to see the crop on foot die away, and accordingly attempted, with some success, to get rid of it, in exchange for rupees. During the present hot weather, during a lengthened tour through these jungles, I have been horrified to find that, what remained uncut of the old stock was dead *on foot*, but that any new crop was quite the exception. The natives affirm, that it takes ten years for the seed to give a full-sized bamboo, *i.e.*, that in the natural course of events, if the seed fell in 1872, it would be next to impossible to find the young bamboos in jungle in 1876. To me this is a serious

anxiety, for not only do some 10,000 square miles of country depend on this supply, but it represents an item of five figures in the receipts of a district, whose total forest revenue never rises above five figures. I trust any of your readers, who have had experience on this subject, will give me the benefit of it.

R. C. W.

INDIAN FORESTER.

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Canson's hydraulic motor and its application to Forest Sawmills. *

BY A. SMYTHIES.

FOREST sawmills in a hilly or mountainous country are placed under somewhat peculiar conditions; they are almost always situated far from regular workshops where their machinery could be repaired; they are generally located in valleys in the middle of, or in close proximity to, the forest, where the streams, without possessing a large body of water, have nevertheless a sufficiently rapid fall to give the requisite power within a short distance, that is to say, the fall enables us to dispense with the cost of constructing a long canal. Thus to utilise the power supplied by nature in mountain streams, we must have a prime mover that is at once simple and solid, easy to repair and keep in good order, capable of working under a small volume of water with a considerable fall, and endued with a high velocity of its own.

Hydraulic movers that have hitherto been employed do not satisfy these conditions in a complete manner; undershot wheels lose a large quantity of the work that the water is capable of performing; breast and overshot wheels labour under the same disadvantage when moving at a high speed; if a lower velocity is given to them, they require extra machinery to multiply the speed, and this increases the cost, makes the sawmill more complicated, and is an additional cause of loss of power.

Turbines which have been introduced more recently are free from these disadvantages, for they move at a high velocity, and

* For the greater portion of these notes, I am indebted to a small pamphlet on the subject by M. Roussel, Professor at the Forest School of Nancy.

A. S.

the proportion of effective to gross work is very great; but in spite of numerous attempts to introduce them into the class of sawmill, we are here considering, they have not proved a complete success. In point of fact, a turbine constitutes rather a delicate kind of machine, the workmen allow bits of wood and stones to enter the interior, and frequent repairs become necessary; we have seen that to obtain these repairs is a matter of some difficulty, and turbines, though well enough adapted to town industries, are not so well suited to forest sawmills as the wheel which forms the subject of this notice.

It was invented by a paper manufacturer in France named M. Etienne de Canson-Montgolfier, I believe about 30 years ago, for in 1849 he brought it to the notice of the Academy of Sciences in Paris, and it is generally called after him, the Canson wheel. His invention soon attracted the attention of engineers, and at the present day there are over 200 wheels on this model working away in the Vosges mountains, a tract of country from its innumerable and rapid streams eminently adapted to this particular motor. I propose to limit my remarks to a short description of the wheel, with some account of its construction, its power of working, and its cost. The mathematical theory, on which the construction of this wheel is based, is ingenious, but it would take up too much space to go into it fully, and moreover it is not probable that it would prove generally interesting.

The annexed drawings will give a better idea of the construction of the wheel than any amount of written description, but at the same time there are a few points that merit special notice, and by calling attention to these, the drawings will be rendered more intelligible.

The wheel is made entirely of iron, and consists essentially of two plane circular flanges, of the same size, and centered on the same axis; it would be more correct to say, of the same diameter, for it will be observed that one of them is full, while the other has its central portion cut out, in order to admit of the passage of the supply-pipe into the interior. These flanges are joined by a series of curved iron blades or paddles, each of which forms part of a cylindrical surface,

whose generating line is parallel to the central horizontal axis of the whole machine. A section perpendicular to this axis shows the blade as part of a circle, which meets the interior circumference of the hallowed-out flange at an angle very nearly equal to 90°, and the exterior circumference at an angle comprised between 20° and 30°. The mathematical theory, on which the construction of the wheel is based, shows exactly what these angles should be in order that the maximum amount of effective work may be obtained, but in this, as in many other cases, it is not possible to follow the indications of theory. For instance, according to the theory, the latter angle—the one comprised between the blade and the exterior circumference—should be zero, but the consideration that plenty of room must be allowed for the escape of the water *through* the wheel results practically in the angle being of the magnitude already mentioned, 20° to 30°.

There is nothing else between the flanges, so the space comprised between two consecutive blades and the flange on either side is a short curved canal, which gradually becomes wider as it recedes from the interior outwardly.

Water is admitted on to the lower portion of the inside of the wheel, and a mere glance at the position of the water-escape box and the conduit-pipe will show at once that it is impossible to strengthen the flanges by any arms or bands in the inside; hence the arms are placed on the outside of the solid flange—the one opposite to the conduit-pipe—and to them the shaft is attached. Thus the whole weight of the wheel acts at one end of the shaft, and though this is counterbalanced to some extent by a fly wheel at the other end, it has been remarked that the shaft ceases to work perfectly true after the lapse of some time. This has also been attributed to the fact that the timber-frame always stopping at the lower part of its vertical course, the water on the opening of the small door in the water-box always strikes against the same portion of the wheel (for to one up and down movement of the timber-frame corresponds one rotation of the wheel as will be seen further on). If this were the principal cause, it could be easily got rid of by adapting a break so as to arrest the motion of the timber-frame

at any point in its course; but this is only a slight disadvantage after all, and has not hindered the successful competition of this wheel with others of a similar kind, against which this fault could not be urged.

The water-box is placed as close as possible to the interior edges of the blades, and a small door, which can be raised and lowered by means of levers from the inside of the sawmill where the men are at work, permits the water to shoot out on to the blades with a high velocity. The thickness of this sheet of water at its exit is equal to the height to which the door is raised, and this is seldom more than two inches. Its breadth is a little bit less than the interior distance between the two flanges, for the water, owing to the great pressure, spreads out laterally, and the width of the door has to be so arranged that the water may just cover the entire width of the blades; otherwise some of the water would escape without doing work, and there would be a loss of power.

The conduit-pipe should be of such a diameter as to convey the whole supply of water without stoppage and no more, *i.e.*, the discharge capacity of the pipe should be exactly equal to the available supply of water; it should have the steepest slope, and as few angles or corners as possible; where elbows are necessary, curves of large radius should connect the straight portions of the pipe, so that all the fluid veins may be considered parallel to each other at any section normal to the pipe. The pipe may be made of sheet or cast iron, or even of pieces of wood bound solidly together.

I have said that the water shoots out on to the blades with a considerable velocity; this velocity differs but little from the theoretical velocity due to the head of water employed, friction in the conduit-pipe being the chief cause of difference. Various heads have been utilised, but 15 feet should be looked upon as a minimum. One sawmill in France works with a head of 72 feet—a thin stream of water—which would give a velocity at its exit from the small trap-door termed the initial velocity of about 68 feet per second. An ordinary head would be 25 feet, and this would give a theoretical initial velocity of 40 feet per second.

The principal advantage of the Canson wheel consists in its own inherent velocity, which varies from 140 to 170 revolutions per minute, thus enabling us to dispense with all machinery for multiplying the speed; hence the connecting rod of the timber-frame is attached directly to the shaft-crank. Here we obviously have a very simple machine consisting of the water-wheel itself, and shaft carrying a fly-wheel and crank in one, and a small eccentric to work the timber-carriage, and it is a machine that very seldom gets out of order, or requires repair.

As the water is delivered through a pipe, any fall however great can be utilised; hitherto turbines alone could have worked with a head of 72 feet; but M. Canson's wheel has this advantage over turbines, that there is no pivot working under water—an arrangement that periodically and frequently gets out of order, and demands the aid of a skilled mechanic to put it to rights; this from the nature of the case is difficult to obtain, and would any how result in loss of time.

There are certain rules for constructing the wheel, which are deduced from the mathematical formulœ; these need not be given here, but it may be remarked that, when it is intended to erect a sawmill of this description, the very first thing to do is to find out the available head, and then to calculate the initial velocity of the water, *i.e.*, the velocity at its exit from the little trap-door in the water-box. The whole construction of the wheel and mill is based upon this initial velocity, so there is no fear of first building the sawmill and then finding out, when too late, that there is not enough water to make the wheel go round. A wheel of this description that has a diameter of 4 feet is considered a very large wheel; many are 3 feet in diameter, some are even less. The drawings, however, will show the real sizes of the various parts, as they were drawn to scale from a sawmill actually at work in the Vosges.

Having said thus much on the wheel and its construction, I now come to its effective power, and the work it is capable of doing.

From experiments carried out by M. de Canson, it was satisfactorily determined that, with a head of 18 to 20 feet,

the effective work was 60 to 65 per cent. of the gross work due to the fall of water. The same co-efficient 0·65 was also found with a head of about 40 feet. With a head of less than 12 or 15 feet, the effective work would diminish rapidly. This proportion of effective to gross work may appear small, but it must not be forgotten that the high speed of the Canson wheel enables us to dispense with all multiplying power, and hence one great cause of loss of work is done away with; and moreover we can utilise much higher falls than is possible with other kinds of hydraulic motors. It may be observed here that the maximum amount of work is obtained in practice by taking the angular velocity of the interior circumference of the hollowed out flange as equal to half the initial velocity of the water.

In France, these sawmills are generally used for converting logs into planking, and almost invariably only one saw is attached to the timber-frame. This one saw tears through the wood at the rate of 30 linear inches per minute, the number of strokes being the same as the number of revolutions of the wheel, in this case about 165 per minute. The actual outturn is 1,600 running feet, or 1,260 superficial feet per day of 20 hours, and this with only one saw in the timber-frame; it must not be forgotten, however, that we are here alluding to the comparatively soft wood of the silver fir (*Abies pectinata*), a very different material to our Indian sál and teak. I regret that I cannot give the real working power of the sawmill from which the drawings were taken, but it was probably not more than 7 H. P., a force that is amply sufficient to cut up heart of oak with one saw at a time; it is improbable that these mills ever exceed 10 H. P., and whether that force is sufficient to deal with sál and teak, I must leave to more experienced hands to determine.

The simplicity of these machines is well illustrated by the establishment necessary to keep them going. In France, the whole establishment employed on the sawmill itself consists of two men and two boys; they work in relays, a man and a boy at a time; the working day is 20 hours, and they can easily reckon upon 300 days work in the year.

A few remarks on the cost of the wheel and of the whole sawmill will not be out of place. The wheel itself in French workshops would cost about 1,500 francs, or say Rs. 700. The mechanism complete would amount to between 5,000 and 6,000 francs, say Rs. 2,000 to Rs. 2,500; and the whole sawmill, building and all, would cost 10,000 francs, or Rs. 4,000. Any good workshop would be able to construct a wheel of this description; for instance, Messrs. Nicol and Co. of Bombay could doubtless turn one out, if they were provided with the requisite drawings and specification; the cost would vary with the current price of iron in the market. The best manufacturers in France are Messrs. Wiedmann Brothers of Rothau (Alsace); others are Messrs. Beyer Brothers of Saint Dié (Vosges), and Messrs. Royer of Epinal, and Goulut of Bru, also in the Vosges.

The foregoing remarks, incomplete though they be, may perhaps serve to draw the attention of Forest officers to a class of sawmill that is simple, effective, and comparatively cheap, requires few repairs, and takes up but little space—which is an advantage sometimes in mountain valleys. The supply of water in India is governed by far different laws to those which hold good in the Vosges; but I am convinced that in many localities out here—and not only in the Himalaya—the requisite conditions for the successful working of a Canson wheel are available, *viz.*, an unfailing supply of a small quantity of water with a considerable head. Whether in such localities there are any State forests, and whether these forests contain any marketable timber, are no doubt considerations that have a prior claim on our attention, but into these it is not my province to inquire.

In conclusion I may state that a small working model of the wheel and shaft has been constructed, and arrangements can be made for sending it by rail to any Forest officer desirous of seeing it, on application to the Conservator of Forests, Central Provinces.

Explanation of the Plate.

FIGURE 1 shows the projection of the wheel on a vertical plane at right angles to the central axis of the machine.

C C the wheel.
P P P three of the blades seen in section.
D D D the water-box.
E E E the conduit-pipe.
A A A the system of levers working on the pivot B.
R a rod communicating with the interior of the sawmill.
W a weight which causes the trap-door to shut of its own accord when the rod R is let go.

FIGURE 2 shows the projection on a vertical plane parallel to the central axis.

L L the arms that connect the wheel to the shaft V.
T the trap-door as it appears when closed. The central portion of the wheel is omitted to show the water-box in position.

The Cultivation of the "Eucalyptus Globulus" and other Australian Gums in India.

For many years past the Government of India has been importing large supplies of seeds of the trees of this family, and chiefly of the *Eucalyptus globulus* (blue gum). These seeds have been widely distributed with the object of acclimatizing such useful trees in the parts of India best suited to their growth. The experiment has not been particularly successful, and in fact it may be said that the trees have lived only in two places, the Nilgiris and Ranikhet. In the Nilgiris their cultivation has long passed beyond the experimental stage. I have seen it stated somewhere that in places the growth of these trees has quite changed the aspect of the country. Official reports all testify to the rapid growth of the Australian gums.

Madras.

In the Madras Forest Report for 1868-69 it is stated of the blue gum that "its rapidity of the growth on these hills exceeds that of any tree indigenous or introduced, and has been the admiration of all forest officers who have visited our plantation." This rapidity of growth was particularly noticed in the sholas, and it was recommended that as these were thinned out for firewood they should be renewed with this tree. "It exhibits the most favourable growth when planted inside sholas of the indigenous trees (particularly in the ravines), as it soon overtops all the native trees, and it has complete shelter from the wind when young. One tree in such a locality in the grounds of Gayton Park at Ootacamund is quite a sight: it is upwards of 12 feet in girth and of enormous stature." The Commissioner of the Nilgiris wrote in December 1869: "It may be said to be established that certain species of the *Eucalypti* grow splendidly on the Nilgiris and four times as fast as the teak-tree grows anywhere, and that the timber of the *Eucalyptus* is at least equal to teak for the various purposes for which teak-wood is wanted." The following is an account given in August 1868 by the Conservator of Forests in Mysore of the Nilgiri plantations of

Eucalypti visited by him in company with the Madras Conservator:—

1. "I have the honour to report, for the information of "the Commissioner, that I lately visited the Government "plantations (at Ootacamund) of *Eucalyptus* and other useful "timber trees, chiefly exotics.

2. "Major Beddome, the Conservator of Madras, at my re"quest, kindly took me over them, and gave me much valua"able information. I would respectfully suggest that, if the "Commissioner should consider the experiment worth trying, "seeds of the various kinds of *Eucalypti* might be obtained "from the Australian Government, and these valuable timber "trees be introduced into Mysore.

3. "In the plantation we first visited, about forty acres "had been planted out with the *Eucalyptus globulus* (blue "gum). The planting was commenced in August 1865, and "the trees had grown capitally. I measured two trees planted "out (seedlings) in 1865. One measured twenty-four feet, "the other thirty feet, to the top of the terminal shoot, and in "girth respectively, thirteen and eighteen inches. Major Bed"dome tells me the timber is equal to teak, and, in spite of its "rapid growth, is good close-grained wood. The growth, in "the Ootacamund climate, of this tree is almost incredible. In "the public gardens is a specimen of *Eucalyptus globulus* now "twelve years old. It is about 100 feet in height and measures "six feet in girth, nearly, at three feet from the ground. This "specimen branches low; but it was grown as an ornamental "tree, not for timber. To thrive well, the *Eucalyptus* requires "an elevation of 4,000 feet; several sites could be found in "Coorg, Munjerabad, and Nagar, for its propagation. It is "very hardy. In the plantations I visited, there had been "scarcely one casualty in the first year; last year some young "trees had been killed by frost, especially those in low and "marshy ground. But, apart from the frost, the tree flou"rishes best in damp ground; the largest tree in the plantation "grew close by the side of a stream, and its roots were entirely "surrounded by water.

4. "The manner of propagation is as follows: Nursery beds "having been prepared, the seeds are sown broadcast (gener- "ally in December or January in Ooty), and covered lightly "with earth to the depth of quarter of an inch. They are "watered copiously. When about three months old, they are "taken up, the roots covered up with earth, and then with moss, "and the plants are in that state placed in fresh beds, or even "(in this climate) simply under pandals, without being put "into the earth. Here they remain for about a month to re- "cover themselves, and they are then planted out in pits or "trenches, each plant being six feet distant from the next. The "dimensions of the pits and depth of the trenches varied "considerably. Some of the pits were three feet cube, "others only eighteen inches cube. The depth of the "trenches too varied from eighteen inches to thirty-six "inches. A uniform depth of two feet and breadth of two "feet for the trenches, or pits two feet cube, would perhaps "be the best. If the spot where the seedlings have been planted "out is well protected from the wind, they require no further look- "ing after. Should, however, the wind get at them, it is found "necessary to remove almost all the leaves, as the plant is apt "to get top-heavy, is blown over and injured. Being planted "out only six feet apart, they draw each other up, and require "no pruning, the lower branches dying off naturally.

5. "If introduced into Mysore, we could not moss the "plants. Major Beddome advised my using bamboo pots, "which have answered well up here. The young seedling, on "being first moved, is put into the bamboo, which is then plac- "ed on the ground under the shade of pandals; when the "time for planting has arrived, the young plant is pushed out "with a stick.

6. "We then went on to Major Morgan's plantations. "Here I saw a thriving plantation of *Eucalyptus globulus* aged "seven years. I measured one specimen. It was four feet "in girth at six feet from the ground, and seventy feet high, "measuring about twenty-five feet to the first bough. The "girth of this specimen was exceptional, but there were several

"hundreds of trees which would have measured about three feet "or three and quarter feet in girth. They were all well grown, "with clean stems, and had never been pruned. They stood at six "feet apart, and Major Morgan has this year commenced thin-"ning them out. Grass grows well under the shade of these "trees.

7. "At Major Morgan's plantations I saw specimens of "*Eucalyptus globosa, E. peperetta, E. citriodora,* several kinds "of stringy barks, all *Eucalypti* from Australia. They were "growing well. Major Beddome advises the introduction of "the following trees as the best known timbers: *Eucalyptus* "*globulus, Eucalyptus sideroxylon,* and *Eucalyptus marginata*—"a valuable timber and said to be obnoxious to white-ants.

* * * * * * *

"The leaves of all the *Eucalypti,* especially when the plants "are young, are full of oil glands. The *Eucalyptus globulus* "leaf has a strong taste of camphor, and goats even will not "touch it."

Large plantations have since been formed by the Forest Department on these hills, and have succeeded admirably. In the plain districts of Madras, however, the attempt to grow the Australian gums has been a complete failure. Repeated notices have from time to time appeared in the public journals on this subject, but the last notice I find is the following quotation from a recent report by the Sanitary Commissioner for Madras:—

"I observe in the newspapers that the subject of the culti-"vation of the *Eucalyptus globulus* in marshy places has been "under consideration with reference to the drainage of village "sites and protection of the health of the people in the Goda-"very district. As the order of Government on this subject "has not been communicated to me, I am not able to submit "any remarks on it; but in regard to the general question of "the cultivation af the *Eucalypti* in the plains of India, I "have the honour to state that the experiment is almost cer-"tain to fail. Looking to the importance of introducing "malaria destroying trees, I have personally been endeavour-"ing to grow the *Eucalypti* in Madras, but, so far, without

"any hope of success. The seeds germinate, and the plants "grow rapidly under shelter, but they seem unable to bear "the great solar heat and die off when planted out. They "thrive but indifferently on the elevated palteau of Mysore "and it is only in our hilly ranges, with elevations of 4,000 "feet and upwards, that they appear to grow vigorously. "Judging from the results of experimental trial of these trees "in Madras, I do not think there is any chance of their flou- "rishing in the delta of the Godavery river. But while the "cultivation of the *Eucalyptus* in the Godavery district may be "impossible, there are plenty of trees which may be substituted "for it. The supposed virtues of the *Eucalypti* in neutrali- "sing miasmata are probably exaggerated, and whatever "power they have in this way is possessed in common with many "other resinous-odoured plants, like casuariana, mango, jack, "&c., which grow freely in the plains, wherever they are plant- "ed and taken care of. I would submit, therefore, that the "spending of money on an exceedingly doubtful experiment "is unadvisable, when experience has shown us that trees of "similar properties with the *Eucalypti* may be raised with "every prospect of success in the eastern coast deltas."

Major Beddome, the Conservator of Forests, is of opinion that the *E. globulus* cannot be grown in the latitude of the Madras Presidency lower than 4,500 feet. Colonel Morgan, Deputy Conservator in the same presidency, says that *E. globulus* is best grown at an elevation of 6,000 to 7,000 feet; the red gum (*E. rostrata*), at 5,000 to 6,000 feet; jarrah (*E. robusta*), at 4,500 to 6,000 feet.

Mysore and Coorg.

The experiments made by the Conservator of Forests in Mysore have not been successful. The first sowings in 1870-71 failed, owing, it was said, to a large proportion of the seed having lost its vitality before receipt in India. In 1871-72 plantations of blue gum were commenced in Nagar "with poor success, as out of 6,490 seedlings transplanted, 5,816 died." In 1872-73 the annual report informs us: "The exotics, chiefly Australian, introduced into the plantations, have failed in large numbers, and those which have so far succeeded require special care. The

attempts to grow the jarrah (*E. rostrata*) in Nandidrug have been successful so far, and the young trees look very healthy.

Bombay and Sindh.

In Bombay, as far as we know officially, no attempts have as yet been made to introduce these trees; but I see it stated in a newspaper that the *Eucalyptus globulus* is thriving in the Victoria Gardens in the town of Bombay. The Commissioner in Sindh has circulated a paper recently written by Dr. Morton recommending the cultivation of the *Eucalypti* in that province, and he has sent for a large quantity of seed with which to commence experiments wherever possible.

Bengal.

In Bengal all the attempts made to grow the *E. globulus* in the Botanic Gardens have failed. The seed sown has often germinated without difficulty, and in quantity. Plants have also attained the height of eight or ten feet, but then they die out. Dr. King says that the chief difficulties of cultivation begin when the roots have become sufficiently long to reach the water-level. He attributes the failure of the tree to the high water-level in the sub-soil, the high temperature, and the alluvial nature of the soil of the province. Recently on a suggestion made by a native newspaper for the cultivation of the *Eucalyptus globulus* in the fever-stricken tracts of Burdwan and Hooghly, a letter was written from this Department to the Government of Bengal, No. 489, dated the 7th May 1874, an extract from which is appended :—

"Although the alleged anti-miasmatic properties of this tree "are problematic, there is no doubt that the introduction of fast-"growing aromatic trees, like the gum-trees, which moreover "produce serviceable timber, can only be advantageous. The "species of *Eucalyptus*, which grow luxuriantly on the Nil-"giris, and which are cultivated in Provence and Algeria (*E.* "*globulus*, *obliqua*, and other species), are from the temperate "climate of Tasmania and the southern parts of Australia. These "do not thrive at Calcutta, and would not thrive in the Burd-"wan district. But there are numerous species of this genus "which inhabit North Australia, Queensland, and other parts "of tropical Australia, which, the Government of India is

"informed, have been cultivated in the Calcutta Botanical Gar-
"dens, but hitherto without success; and I am to suggest for
"His Honour the Lieutenant-Governor's consideration that
"Dr. King might be encouraged to persevere in his attempts
"to introduce the gum-trees of tropical Australia."

Dr. King says that even these species have never succeeded in Calcutta, but he has sent for seed in order to carry out the experiments suggested, and promises to report the result. There are now, Dr. King reports, about sixty or eighty gum-trees in the garden, many of them being from fifteen to twenty feet high.

It is understood that the experience of the Calcutta Agricultural and Horticultural Society is much to the same effect as Dr. King's.

Assam.

In Assam the only record of an attempt at the cultivation of these trees that I can find is recorded in a recent report of the Agricultural and Horticultural Society. Dr. Imthurn, stating the result of an attempt to grow the *Eucalyptus globulus* at Tezpur, Upper Assam, writes as follows:—

"I found it impossible to get the seeds to germinate in the
"open, apparently owing to the soil being too moist.

"Sown in pots, the seeds germinated pretty freely (from one-
"third to one-half of the number sown). The time required
"for the germs to appear above ground was from five to twelve
"days, generally nearer the former term. The young plants
"unfortunately look weak and premature, and are very slow
"in making leaves.

"The stalk bearing the cotyledons seems to have grown too
"fast, and proves too tender. Heaping up fine earth round
"the stalk does very little good beyond preventing the stalks
"from bending under the weight of the cotyledons.

"I have often noticed the same premature state with cold
"weather plants, which I wanted to raise during the rains so as
"to have early seedlings. Its causes are, as far as my experi-
"ence goes, either—

"Too rich soil or
„ much humidity, or
„ little light (reflected or directed) or
„ high temperature.

"I have varied my experiments so as to satisfy myself that "the premature state of the young *Eucalyptus* plants is not "due to any of the first three causes just mentioned, and it "seems, therefore, that the high temperature was the cause of "the weakly state of the young plants."

These remarks having been referred to Mr. Kurz, of the Royal Botanic Gardens, he said that in his opinion the failure of *Eucalyptus globulus* in Assam was ascribable both to too great moisture and heat.

"It is true that the tree grows best in moist valleys of Vic- "toria and Tasmania, and must there be subjected to a good "deal of dry heat during the hot season; but still the distri- "bution, which ranges from 37 degrees to 44 degrees south lati- "tude, indicates its unfitness for the Assam climate, while it will "no doubt prosper in the North-Western Provinces, &c., and still "better in the Mediterranean countries.

"Dr. F. v. Mueller has sent us another species less temper- "ate than the above, *viz.*, *E. rostratus,* and I enclose a few "seeds for Dr. Imthurn for an experiment in Tezpur. Dr. "F. v. Mueller thinks that this is the best kind for tropical "regions in India, and possibly Dr. Imthurn may be inclined "to try it and let us know by-and-bye with what results."

These seeds were sent with Mr. Kurz's remarks to Dr. Imthurn.

North-Western Provinces.

In the North-Western Provinces, Kumaun is the only locality where experiments have been officially tried. In his report for 1870-71, the Conservator wrote:—"The climate and soil of Ranikhet are evidently well suited to the Australian gum-trees. We have now gained considerable experience in the cultivation of these very valuable trees, and I am convinced that the best mode is to break up patches of ground and sow the seed broadcast on the spots the trees are to remain on; for although the young saplings are not killed by transplanting, their growth is very considerably delayed. The seed should be sown in the rainy season, and it will then germinate in about eight or ten days. The blue gum is doubtless the quickest grower, and will do well enough for fuel; but I

doubt its being of much use for timber, and I am rather afraid that it will be liable to get broken by the severe gales of wind peculiar to the Himalayas. . . . I have directed Mr. Craw to break up open patches of ground in the forest and sow all the gum seed he has, and next year I mean to go on with this work on an extensive scale, and there are many acres of small open spaces on the Ranikhet hill which I hope to get covered with gum-trees in this way."

He was also going to try further experiments at Chakrata.

In 1871-72, Mr. Craw reported from Ranikhet:—"7,600 gum-trees have been planted in cantonments, and with few exceptions are doing well. * * * In February last, about 300 gum seedlings were taken from the Ranikhet nursery and planted at Mohahu (Kumaun). By the end of June, these little trees had grown from four inches to six feet in height, but I have since heard that many of them died soon after the heavy rains set in. If this is the case, the gum tree will not do in such a damp climate as the Bhabur. A small quantity of gum seed was sown near Chakrata, but the heavy snow of last winter rotted it, and not one single seedling appeared. However, I fear the gum-tree is not suited to that cold and bleak climate."

Mr. Craw's last available report, dated 26th March 1873, shews that he had then between 15,000 and 16,000 gum-trees, and was expecting a large increase to his stock from fresh sowings. He considers that they have become acclimatized at Ranikhet, and gives some measurements in support of his opinion. The oldest of the gums, planted in August 1869, was 30 feet high when he wrote, and a number of others planted in August 1870 ranged from 15 to 20 feet, the average being nearly 18 feet. He finds the seeds succeed best when sown in early spring. The young plants thus attain a few inches in height before the rains set in and are not liable to rot off in the seed beds or in transplanting, which they do when from any cause the sowing has been unseasonably deferred.

Colonel Ramsay says that the *Eucalyptus* grows admirably at Naini Tal at an elevation of 6,700 feet, and at Donagiree

at an elevation of 6,500 feet, "therefore" he says, "it may be fully admitted that it does not suffer from the frosts to which hills to a height of 7,000 feet are liable." Captain Birney in a small experiment found the *E. globulus* the quickest grower of the seven gums he tried, it attained a height of six feet in one year.

Punjab.

In the Punjab repeated attempts have been made by the Forest Department to raise the various species of this genus. In his *Punjab Plants* (page 93) Dr. Stewart says :—"These Australian trees have as yet not been found easy to raise in the Punjab, although improvement is taking place in that respect. But several of the trees, which have succeeded at Lahore and Madhopur, where they were first introduced in 1860 by seed obtained from Dr. Chalmers, have grown at least twice as rapidly as the ordinary Punjab trees."

Dr. Stewart does not specifically mention the blue gum, and it is not probable that this was one of the kinds which he mentions as having succeeded. Seeds of *E. gigantea* (from Adelaide), *E. sideroxylon* (iron-bark, from Victoria), and other species have been obtained from time to time and tried in the Changa Manga plantation without success. The blue gum always failed. Writing in April 1870, Mr. Baden-Powell reported that the experiments had been "so very satisfactory that a more systematic effort to grow the tree on a large scale is desirable." He said that *E. sideroxylon* had been very successful. Further experience however caused Mr. Powell to change his opinion. In February of the present year he wrote: "The only place we grew gums was at Changa Manga, and the plantation officers there have tried all sorts of species. We obtained a large amount of seed, gave it a fair trial, and concluded that our plains do not suit the *Eucalyptus* species, but that the lower hills would be their proper place." Of the *Eucalyptus globulus* he said: "It is *the* most difficult of all the gums to rear in the plains. They have been tried and always failed at Lahore. I had one, I think about the third or fourth in all Lahore, that survived and grew just as Mr. Hume describes, in a hectic, unhealthy sort of way." These remarks were made

on a request from the Government of the Punjab for seeds of the blue gum, which Dr. Scriven, attracted by the newspaper reports of the properties of the tree, wished to try in the central jail. He also recommended its being planted along the banks of canals in those districts where the canals had increased fevers. This Department asked the Government of the Punjab to enquire into the results of the trials made at the Changa Manga plantations, saying that if after considering them it was of opinion that further trials would be useful, the application for seed might be renewed. This was last February, but no further communication on the subject has been received from the Punjab. There is a blue gum at Simla in the grounds of the Simla Bank. It is not a particularly good specimen, but its existence shews that when once established the tree can stand frost fairly well. This tree is some years old. I sowed a quantity of blue gum seed at Simla in the spring of last year. The plants grew rapidly, and I gave away a number of them when they were about a foot high. Those that I kept stood the winter fairly, though it was very severe, and were in good condition when I left at the end of January. But it was evident that if they had not been sheltered the seedlings would have perished, and it seems certain that the frosts of Simla are too severe for the tree in the early stages of its growth to admit of its satisfactory cultivation on a large scale at that altitude.

Oudh.

In Oudh the *Eucalyptus globulus* has been tried without success by Dr. Bonavia. In his report for 1873-74 on the Lucknow gardens, he writes:

"So much has been written lately about the *Eucalyptus* that "a few words upon it may not be uninteresting. Several years "ago some seed which was ticketed *E. globulus* germinated well, "and several of the plants throve and were planted out. Most "of them died one rainy reason. Two escaped and grew to "about 30 feet high. The leaves had a bluish bloom on them "and were very fragrant. The leaves of the lower part of the "tree were totally different in shape from the upper ones. Both "these trees died during a subsequent rainy season. I have "now in the Horticultural garden 22 trees of another kind of

"*Eucalyptus*, which Dr. King, the superintendent of the Royal "Botanic Garden, thinks is the *Marginatus*. If so, he states "it is a very valuable timber tree and equal to the mahogany. "This kind thrives very well. Some specimens, I should say, "are about forty feet high. They don't mind the hot winds, "the rains, or the frost. Some have flowered but not seeded yet. "This may be a good kind to introduce into the Oudh forests."

We have no record of any other attempts to introduce the the blue gum into Oudh.

Central Provinces.

In the Central Provinces the only attempt made, as far as we know, is a recent experiment by Colonel Wood, Deputy Commissioner of Sironcha, who brought out a large quantity of seed with him after his return from furlough, meaning to introduce the tree in the Central Provinces. I can find nothing as to the result of this experiment.

Nicobars.

The only other place where, so far as our knowledge goes, *E. globulus* has been tried is in the Nicobars. The seedlings appear to have done fairly there yet, but the success of the experiment is problematic. A report has been called for after a year's experience.

Thus it appears that after repeated experiments the *Eucalyptus globulus* has succeeded only at Ranikhet in the North-Western Provinces and on the Nilgiris in the Madras Presidency. Even in Mysore and Coorg, at an elevation which might have been supposed not unfavourable to the tree, it has failed. Heavy charges have been incurred from time to time on account of the importation of seeds from Australia, and it seems questionable whether it is worth while going to much further expense in the attempt to introduce the tree on the plains of India. It is a native of the cool, temperate zone of the Australian continent and Tasmania, and its unsuitability to the tropical plains of this country seems now manifest. It might probably succeed well on the lower ranges of the Himalayas. In these localities it is hardly wanted as a malaria-destroying agent, but it might be useful in the reboisement of such bare places as the chain between Kussowlie and Simla. The aroma-

tic emanations from the tree are so strong that it is said cattle will not touch it. In this respect and in its extremely rapid growth (at Ranikhet the growth of a particular tree during the course of a year measured no less than 18 feet) it possesses great advantages.

Certainly, if the tree possessed all or even half the virtues currently attributed to it, Government would be bound to make the most strenuous efforts, without reference to cost, for its universal establishment in India. Here is a list of some of the virtues ascribed to it: When thickly planted in marshy districts the subsoil is speedily relieved of its superabundant moisture as if by pipe-drainage, the tree absorbing daily ten times its own weight of water from the soil. Miasma ceases wherever it flourishes, and fever flies before its face. The healthiness of the Australian climate is caused by the emanations from the tree. The bark and leaves possess febrifugal and antiseptic properties. It is valuable as a disinfectant and as an active agent in the treatment of diseases of the larynx and of the mucous membrane generally; its leaves make a good lozenge for the throat, and baths in hot water, in which the branches and leaves have been infused, remove rheumatic pains, neuralgia, and the debility left by malaria. It is praised as a perfume (to which the name *Eucalyptol* has been given) and as a cigar to promote digestion and for bronchial and asthmatic affections. And last, but not least, it has been discovered to be an infallible remedy against the phylloxera vastatrix, thus: inoculate the vine attacked with the pure essence of *E. globulus*, and in three days the phylloxera entirely disappears, while the vine is uninjured. It is not stated that the abbé who made this great discovery has claimed or received the reward of three hundred thousand francs offered by the French Government.

This catalogue of the virtues of the blue gum makes one think of the wonderful powers supposed three hundred years ago to be possessed by that "most holy herb," tobacco. Clearly such statements want confirmation before they can be accepted. They bear indeed on their face the mark of exaggeration. In one of the papers in which an account of the properties of the tree is given, it is stated that the British Government has

largely grown it in India and on the west coast of Africa with astonishing results in the diminution of fever. Now we know that in India no such results have been obtained, and on the west coast of Africa attempts are only now being made to introduce the tree, and Dr. Hooker is very doubtful of its succeeding there. Mr. Broughton, Government Quinologist at Madras, has examined the bark and leaves of the tree with the result stated in the report to the Government of Madras appended, dated 29th May 1872:—

"Much has lately appeared in the papers and quasi-"scientific journals concerning the valuable qualities of the "*Eucalyptus globulus* as a febrifuge. In the *Lancet* for 20th "April 1872, a notice is given of the uses of this tree me-"dicinally, in which it is stated that all parts are most valu-"able as a febrifuge medicine, and also that the leaves, when "smoked, are most efficacious in allaying pain, calming irri-"tation, and procuring sleep. This article furthermore in-"forms us that Professors Vauquelin Leiciana obtained an "alkaloid from the bark which crystallized like quinine as a "sulphate, and which yielded the ordinary reaction of quinine "with chlorine, water, and ammonia. I have examined the "bark and leaves of the *Eucalyptus globulus*, and have the "honour to state that neither quinine, quinidine, chinchonidine "nor chinchonine is contained in the plant in any proportion."

The only precise instances of the removal of fever by the agency of this tree are those given by M. Gimbert in his paper read before the Académie des Sciences, on which the numerous articles which have appeared in the journals lately have been based. The cases quoted are certainly remarkable if they can be accepted without qualification, but Dr. Hooker, on the other hand, says that he has failed to discover that the reputed virtues of the tree have any certain foundation.

However, without discussing the question of its febrifugal and antimiasmatic qualities, there can be no doubt that the *Eucalyptus globulus* is a very valuable tree. Its timber is excellent, very strong and durable. At the Paris and London Exhibitions the wood was mentioned in high terms as very suitable, from its hardness and durability, for various purposes,

and especially for ship-building, as it resists the attacks of insects in the water. At the Paris Exhibition of 1862, the wood was recommended as well adapted for railway sleepers. M. Trottier, who has written a pamphlet on the cultivation of the blue gum in Algeria (where it is now largely grown), calculates that in eight years a tree would be sufficiently large to cut up into sleepers. In Australia the timber of the blue gum is greatly used by colonial shipbuilders and by millwrights, carpenters, and makers of implements, as well as by engineers in the construction of works requiring beams of great span. Mr. Broughton reports that the tree produces a gum resin in *considerable quantities, closely resembling kino in its properties.* He found it yield no less than 43 per cent. of tannin, and he thinks it probable that the gum would be found valuable as an astringent medicine. Its growth, as has already been said, is astonishingly rapid.

But if the reputation of *Eucalyptus globulus* as a sanitary agent cannot be confirmed, it will probably be advisable not to waste money in further attempts to naturalize it on the plains. There are many other species of the same family which, as natives of the hotter parts of Australia, will probably succeed perfectly in the plains of India. Their growth, like that of the blue gum, is rapid, and the timber of many (that of the jarrah for instance) is excellent. The propagation of *Eucalyptus globulus* should be confined to those localities which are known to be suited to it.

Appended is a memorandum on the method of planting the *Eucalypti* by Colonel Morgan, Deputy Conservator of Forests in Madras, with marginal notes by Captain Campbell Walker :—

Memorandum on the planting of Eucalyptus, by Colonel H. R. MORGAN, *Deputy Conservator of Forests, in charge of Mudumallai, &c.*

"The seed, which should be procured in January or February, "should be placed in beds in rows 6 inches apart.

2. "When the plants are 6 inches high, they should be "taken up and placed 6 inches apart in beds; the roots should "be shortened to 4 inches.

3. "When 3 feet in height, the plants are taken up with a "ball of earth round their roots, moss is bound tightly round "the ball, and the plants are left in beds well earthed up about "the roots and watered till the young rootlets show through.

4. "They may then be put out. April is the best month "for planting, as the plants are then able to make strong roots "before the monsoon.

5. "When moss is not available, bamboo pots may be used, "taking care to keep the large end of the joint for the top of "the pot; the hole at the bottom to be plugged with grass. "The plants should be placed in the pots when 8 inches in "height, and left till they are 2 feet high and the roots show "through; then thrust the roots through, and the plant comes "out with a ball of earth attached to the roots. Pits should "be 18 inches cube.

6. "In the second year it will be necessary to prune the "trees heavily to remove all sidebranches "but the three pairs at the top.

NOTE.—I do not like to advance theoretical opinions in opposition to Colonel Morgan's *experience*, but I cannot help thinking this pruning might be dispensed with, and the trees left to nature.—C. W.

7. "*Eucalyptus globulus* is best grown "from 6,000 to 7,000 feet elevation; the "red gum (*Eucalyptus rostrata*) from 5,000 "to 6,000 feet; the jarrah (*Eucalyptus* "*robusta*) (*marginata?*) from 4,500 to 6,000 feet. If the situation "is very exposed, place your trees 4 feet apart in trenches 18 "inches wide and deep.

8. "In rich soils thinning may be necessary in the seventh "year; in poor soils, the tenth year. Grass "land is best broken up by heavy ploughs, "and if a crop or two of potatoes or oats "are taken off it, the better for the plants. "A tree of *Eucalyptus globulus* at twelve "years of age in good soil will weigh a "ton."

NOTE.—I have seen plantations in which thinning was absolutely necessary in the fifth year. No rule can be laid down, as so much depends on soil and exposure, and the object for which the trees are grown.—C. W.

J. E. O'CONNOR.

On a new test for ascertaining the Season at which Timber has been felled.

A PAPER presented by M. Prillieux to the Central Agricultural Society of France contains some interesting observations on the means of ascertaining the season in which the trees that produced timber offered in the market were felled in forests. The season in which trees are felled seems to exercise a great influence on the durability of timber used for building purposes. Timber obtained from a tree felled at a season when the sap is in full flow is, it is believed, more susceptible to decay than timber from a tree felled in winter. This belief is general and of ancient date, and it is confirmed by daily experience and by the results of several inquests held under orders of the Courts (in France) for ascertaining the causes of decay in timber used in newly constructed buildings.

But if architects and builders are unanimous in recognizing the danger there is in using indiscriminately wood obtained from trees felled when in full sap, they are also absolutely without the means of telling the difference when once the timber has

been promiscuously stored in depôts. Builders are therefore in a very sad predicament; since they know that the quality of the wood varies markedly according to the season in which the trees are felled, and yet they have not the means of distinguishing the quality of the timber they use. On this point however pure science is able to co-operate successfully with practice, and the question of practically determining the season in which trees have been felled may be solved by following the indications furnished by vegetable anatomy and physiology.

We know that in living plants the organic elements of nutrition which are assimilable, are, during the season of active vegetation, formed in superabundance, *i.e.*, in excess of requirements of nutrition. During summer and autumn this surplus is deposited in reserve for future use in the cellular tissue or *parenchyma.* Sometimes these organic substances accumulate in the form of sugar as in the case of the beet root: but more frequently—and especially in the case of trees—in the shape of starch in deposit in the cells of the pith and of the woody cylinder (medullary rays and woody parenchyma). In spring when vegetation recommences, these organic assimilable substances are absorbed and used up in the process of growth, during the interval which must elapse before the leaves are fully developed to perform their functions.

Such being the normal course of vegetation, it is only reasonable to suppose that on examination we should be able to detect in those wood cells which are the special storehouses of such substances, some marked difference of appearance which would inform us whether the trees were felled in winter or when the sap was in flow. The investigation was full of interest. M. Prillieux was enabled to experiment on samples of oak timber of known origin, that is to say, where it was known for certain what samples were felled in winter without sap and what were felled in spring. He found that wood from trees felled in winter (when the sap is dormant) contains in the cells of both the medullary rays or of the *prosenchyma* abundance of starch in minute grains called starch granules, whereas the cells of wood felled when the sap was in flow, on the contrary, contained *none.* The property which a solution of

iodine possesses of turning starch to a violet colour permits us to detect the presence of the latter in wood and especially in oak, in which large medullary rays exist easily visible to the naked eye. In this case the presence of starch is visible without the aid of a microscope. If a transverse section of wood felled in winter be treated with a weak solution of iodine it will shew the medullary rays in the shape of dark lines (nearly of the color of ink) which are thrown out in relief from the yellowish surface of the section. This is due to the discoloration, under the effects of iodine, of the cellulose fibres, cells and vessels of the wood containing starch. No such result is to be seen in a section of wood felled when *in sap and subjected to the* same treatment with iodine. In the latter case the whole surface of the section remains of a uniform yellowish color; and the medullary rays of the wood are only distinguishable by their lighter shade.

When sections of timber treated with iodine, as above explained, are viewed through a microscope, the cells of the wood rich in starch are clearly visible, and the presence of the organic assimilable substances is also easily discernable, not only in the medullary rays, but also in the woody cells. In many doubtful cases the use of the microscope may be necessary; but in the few experiments made by M. Prillieux on specimens of timber felled at different but known periods (some during winter, others during spring) the indications described were clearly visible to the naked eye.

This test therefore offers to architects and others a criterion for distinguishing the different periods in which trees are felled, provided such test may be relied on always to furnish definite and unvarying results. The observations hitherto made are too few to establish conclusively a theory on this point, and M. Prillieux therefore limits himself to inviting inquiries by timber merchants, and Forests officers who are in a position to make further trials with timber of different ages the period of the felling of which is positively known. It is only after repeated experiments under varying conditions that we shall be able to place this method beyond doubt.

E. De Dombal.

Report on the Gums, Resins, &c.

In the Indian Museum, produced in India (under the direction of the Reporter on the Products in India) by Dr. M. C. Cooke, 1876.

By B. H. Baden-Powell, F.R.S.E.

It is to be hoped that this useful report or catalogue *raisonné* of the gums, resins, &c., produced in India, will be available for study by all those Forest officers who take an interest in scientific but practically useful subjects. The mistake is often made of expecting Forest officers, burdened as they are with work of their own, to undertake to investigate and report on

the whole of an extensive subject; the report is called for, and reminders are sent probably within a month or so, and the consequence is that nothing is elicited.

But, with a report like this before them, it will be easy gradually to collect specimens and information. If every Forest officer would only take up *one* individual gum or resin which is doubtfully given in the report, and give his own actual observation, a correct nomenclature, the true habitat and (in cases where he is not certain of the tree) a good dried specimen, in a short time most of the doubtful points in such a report would be elucidated.

I may here mention that lac does not form one of the products included in the report, but that authentic specimens of the lac in its natural state on different trees (with botanical specimens, where the species is not known for certain), and specimens of the insect in all its stages, are desiderata at the Indian Museum and also at Lahore. Will no Forest officer of the Central Provinces respond to the want?

But to the Report. The first thing that strikes one is the want of a table showing abbreviations used for provinces, &c. What do *Duh*, and *New*, and *Parb* mean? "Tam" is presumably for Tamil, "Dek" for Dekhan, and "P." for Persian; "Punjabi" is ignored.

Next the vernacular spelling is (as regards the names in languages with which we Northerners are familiar) a perfect hash. Very often also different varieties of barbarous spelling are given as if they were "synonyms."

Now, as regards the languages, Arabic, Persian, Hindi, Urdu, Punjabi, Pashtú, Bengáli, and Sanskrit, the only natural system is to use consonants as in English. The diacritical points are too elaborate for common use, though of course their adoption would be a benefit. It is practically enough however to distinguish the nasal "n" by a dot, thus ṅ; and the *'ain*, by an apostrophe; the guttural "gh" and "kh" by a line drawn under, thus i$\underline{h}$, $\underline{kh}$.

In vowels the continental sound is given.

The short vowels a, i, u, are always sounded like the "a" in organ, the "i" in will, and the "u" in put.

The long vowels á, í, ú, to be always distinguished by an accent, have the sound of pass, sweet, pool.

The "y" is used *only* as a consonant; as in the word níyat (nee-yat); combinations therefore intended to represent vowel sounds, as "ay," "ey," "oy" are inadmissible.

The "e" is always as *é* in French, "ai" is always as the *i* in "price," "au" as *ow* in "now." No such combinations of vowel sounds, as "ou," "ow" should ever be used.

I do not of course offer these remarks as regards Telugu, Tamil, Kanarese, or Cingalese, of which I know nothing. For Burmese, the *vowel* sounds are more numerous, and will require some further device, *e.g.*, the words hle, hlé, hlă, and hlá, mean "boat," "cart," "beautiful," and "city," and require nice discrimination.

Some instances (merely by way of example) may be given out of the report.

Samaghe-arabbi	...	*for*	Simagh-i-'arabí	(p. 3).
Kheir Khuera, &c.	...	"	Khair, Khairá	" 5).
Ran-sirrus	...	"	Ban-siras	" 6).
Lall-kheir	...	"	Lál-khair (red khair)	" 7).
Bael	...	"	Bel	" 8).

The names of *Armeniaca vulgaris* (p. 9) are unintelligible for want of accentuation. In the plains of North India jaldárú (which is a corruption of zard-árú, *lit.* the "yellow peach"), barzhá (Pashtu), chír, hárí or sárí (Hills generally). Chúí is an *apple* in Chamba.

Azadirachta should be ním (Persian form), and nímb (the Hindi form) (p. 9).

Jamoon *for* jáman (N. India,) jamú (H.), p. 10.

Careya arborea.—The Burmese name bam-bhú-wé only "bam-bonay" does not exist (?) The *Bengalee* name "ban-bham-booai" is, I believe, nonsense, being a jumble of Hindi and Burmese (p. 12).

Citrus, sp.—The names are much confused: nímbú or límú is the generic Urdu name, and does not indicate different species of lime. The latter are distinguished by "míthá" and "khattá" for sweet, sour, &c.

Emblica officinalis.—Amla or áṅwlá are the two forms of all the dialects.

Melia azadirach.—The name is bakain. This species and *M. sempervirens* are used confusedly for the same tree in Indian books. It is now settled to use *M. indica* for nim, and *M. azedarach* for bukain or drek (p 20).

Fool ... *for* phúl ... (p. 20).

Prosopis spicigera.—The common N. Indian (Punjab) name is "jhand."

Ara-bukhára *for* álú-bukhárá (p. 23.)

Anar *for* anár darim *for* dárim.

Gulnar *for* gul-ánár is the "flower" of pomegranate, not the tree or its gum (p. 23).

Semecarpus.—Beládar is Arctic, and bhiláwáṅ bhiláma in all Hindi dialects; various spellings given (p. 24).

Tamarindus.—Imlí or amlí in Hindi dialects, thamr-i-hind (Persian) (this "th" is pronounced in India like s). Amblie is not an Arabic word as stated.

Tamarix.—Pilchí, jhau, farásh; are names not given. The now-settled species are *T. gallica* (L.), pilchí, leí; *T. dioica* (Roxb)., pilchí and kachleí (a mere shrub which does not give a gum), *T. articulata* (Vahl.), the farás (H.), farwá or úkhán (Pji.) This latter is the biggest and the one that yields gum.

Terminalia.—Bahera (Hindi), balela (Persian), spelt "beley-lep" (p. 26).

Wrightea.—Dúdhí (W.) is *W. mollissima* (p. 28).

W. antidysenterica is indarjau or indarlatíb.

Gossypium is *katírá or katírá* Hindi (*p.* 30). The Arabic or Persian would be simagh-qutn-i-hind, not "qutade" as given.

Pterocarpus.—Dammul akhvaine *for* dam-ul-akhwain, khune sugavashane *for* khún-siyáwashán (p. 36).

Mucherus *for* Mochras (p. 40).

Ausarake revan *for* 'usára-rewand (Persian), (p. 43 and p. 46.)

Ush-shaq *for* ushaq (p. 37.)

Barazd *for* barzad (p. 60), and rhulyan *for* kalbán, and metonioon *for* mítúbiún; perhaps these mistakes are Royle's, somebody having misread the "be" and "ye" and "nún," all of which differ only in the points (*id*). A similar mistake occurs

at p. 112, where whatever the extraordinary word aqovo yala samun may be, the latter member of it is balásamún.

Sugbeenuj *for* sak bínaj, and kundel *for* kundal (p. 63).

Aflatan *for* aflatún, and bui tahadan *for* bú-i-jahúdán (p. 72).

Eng-gyín (eng-gyeen) which in Burma is *Pentacme siamensis* (Kurz), not *Shorea robusta*, and the-yá enggyín is *Sh. obtusa.*

The Arabic and Persian names are unintelligible (p. 90).

Trachylobium.—The common name "sundras" not given (p. 98) save as "sandarus" in a quotation: Arabic is sandarūs.

Uluk baghdani *for* Alk Bághdádí (twice) (p. 105.)

Balsamondeandron.—The Arabic is unintelligible. Persian should be raughan-i-balsán (p. 112).

Gorjon tail *for* gurjan-tel (H. and B.) (p. 113.)

The Burmese is kanyín-tsí, or oil of kanyén.

Melanorrhœa, in Burmese thitsi, "wood-oil or varnish;" the other names are probably mis-spellings (p. 120).

Pinus longifolia should be gandah-biroza-ká-tel, or simply gandah-biroza.* The Dekhan corruption is firoza. Persian is raughan-i-ratiánaj.

Knel *for* kail (p. 124).

Abies Smithiana.—The names are rau or khatrau varied locally into kundrau and kudrau, &c. (p. 127).

Tectona grandis.—Sígun is the word given by Shakespeare for teak, called also in Bombay, and elsewhere, sagwán or sagon. Our word teak comes from the South Indian name (teka, &c.,) in Burmese it is kyún: this is omitted (p. 129).

These are only a small number of cases taken at a casual glance. I have not the means at hand of correcting the Arabic and Persian names; they are nearly always wrongly spelt. Under A. Arabica I notice that "kíkar," which is the common *North* Indian name, is referred to *duh* (whatever that may mean). Linguists will be interested to notice how the more Southern or (Hindi proper) name, bábul is derived from the Sanskrit "barbura," and passes into bábul (Hindi and Bengali); the latter given as babuler (?) into "báblí" of the Mahrattas, and "bávlí" of the softer Gúzarátí.

* J. and Z. are vulgarly interchanged by Hindus in pronouncing words of Persian origin.

Under A. *Persica* "arú" is the common N. Indian name; gharghastai is Pashtú, chinnánu not chimnánu is a very local name conferred to Pangi—the upper Chináb valley.

Affixes or suffixes which signify "tree" or "gum" or "oil," as "khair ká lakri" (khair wood,) "eng-ben," "shá-ben" (*ben* being "tree" in Burmese,) nim-gachh (Bengali,) thingán-tsi (tsi meaning wood-oil), should be discarded, and the name only given. If the usage of the language requires the addition, this should be noted.

A few notes of some of the doubtful points, the clearing up of which would be interesting, may now be given. It is hoped that some persons will find time to clear up one or more of them.

Acacia Arabica.—The habitat of the species is not properly given; it grows all over India in the plains up to the Indus; it abounds in alluvial lands in Sindh.

Generally speaking, it would seem that the southern localities produce a darker gum than the northern.

What is the proper season for collecting the gum, and how is it effected?

Acacia Catechu.—Have samples of the Burmese product been sent to the Museum? the extract is however not treated of in the report, only the gum: is this ever collected in Burma?

Siris.—Authentic specimens of this gum are needed; we have the common roadside siris (A. Lebbek Willd) and others, the A. procera (Benth.) with white bark called dhún or safed siris, and *Albizzia odoratisima* which is also called siris or laorin (sub-Himalayan.) The latter yields a dark brown gum (Brandis).

Acacia Modesta.—A characteristic habitat of all hills and jungles in N. W. Punjab is omitted.

Apricot.—I believe the gum is commonly collected in the hills where the apricot (with a small indifferent fruit) seems almost wild.

Nim.—Authentic specimens of this gum are required.

Bauhinia.—Does the climber in the Terai forests yield a gum? (*B. Vahlii*).

TOON is said to yield a gum: this requires verification. Dr. Cooke says from the character of the timber it should be a resin. I see no reason for this; it is a scented wood; but in no way resembles any resiniferous tree.

CELTIS.—In species in the Punjab hills do they yield gum? (BRANDIS puts them under one *C. australis L.*) We certainly have two plants, the Chamba *celtis* (khark) and that of Hazara, to appearance very distinguishable. STEWART calls the latter (batkar) *C. Nepalensis* (Punjab Plants, 210).

GOSSYPIUM.—Common cotton plant. This is said to yield a gum. Surely, it must be a mistake. Dr. Cooke speaks (under this head) of cotton-tree gum; does he mean *Bombax malabaricum* (*Salmalia malabarica*, Schott.,) and which is called the "cotton-tree?"

HERITIERA LITTORALIS.—Dr. Cooke says he has no evidence whether produced in India. It certainly is a characteristic tree of the Sunderbuns in Bengal, where it is called sundar or sundrí. Does it yield a gum?

BAKAIN.—Is there really a gum of this species?

MULBERRY.—Is there a gum from this? if so, it could be had in large quantities.

ODINA WODIER, *Jingan.*—Will some officer undertake this species and clear up the subject which ought not to be difficult? It is said by some authors to give a *resin.* Then again it appears under the head of *varnish* yielding trees at page 123 of the Report. This tree seems to extend over the whole of South and Central India, and to North India as far as Oudh and the N. W. Provinces, and even sparingly into the Punjab in the lower hills as far west as the Sutlej region.

There is no sort of doubt that the jingan gum of this tree as found in the bazars below Simla, is white and soluble, and that in Hoshyarpúr species have been obtained of a clarified gum. It seems equally certain that a dark gum is yielded also, called "kauígond;" this I have never seen. Will some one collect real *odina* gum, with a specimen of the tree to prove its identity in each case.

The resin appears to me to be wholly a fallacy and also the wood-oil. I have little doubt that some people got hold of

the Burmese thingan and mistook it for jingan or jhingan, the easy confusion of J. and T. being obvious.

Thingan has of course a woodoil or oleo resin.

Forest officers should be able easily to clear up the question.

SAPINDUS.—The soap nut tree (ríta). *Does this really yield gum?* and which species? *S. acuminatus (S. detergens,* Roxb.) or *Emarginatus.*

SEMECARPUS.—(The marking nut tree). The same question has to be asked: BRANDIS says a brown nearly insipid gum exudes from the stem.

SPONDIAS is not common in the Punjab, where it is small, and grows only as far as the Salt Range; but it grows to an enormous size in Burma (Pegu), where it is called kway-ben (Kwé-ben); specimens of its gum are wanted.

TAMARIX-DIOICA (should be *T. articulata*). *T. dioica* does not yield a gum that I know of, where is it called asul? the common North Indian names are "farásh," "farwá," and "ákhán."

The TERMINALIA gums want investigating. Does the saj or asan *(C. Prov.) yield gum?* and of what sort? Does bahera in Midnapore forests?

VACHELLIA.—The genus is not now distinguished from *acacia.* I believe Acacia Vera, A. Arabica, and the so-called Vachellia are practically undistinguished: as regards gum, *Acacia Farnesiana* gum, BRANDIS says, is collected in Sindh.

Zizyphus flexuosa.—I feel sure this is a mistake, and that "simli" of the Central Provinces has nothing to do with *Zizyphus. Will some Central Province forester send simli* gum with a specimen of the tree?

Zizyphus flexuosa (Z. vulgaris, Lam.) is not the common "ber," which is *Z. jujuba,* Lam. (var *Hysudrica,* Edgeworth). *Z. flexuosa* occurs chiefly in the N. W. Punjab and in Hazára under the very local name of sinjlí. I never heard of any variety of "ber" tree giving gum; it is one of the lac trees.

With regard to the DOUBTFUL GUMS on page 29 (a great many more are very doubtful I think), "*dhas*" gum is probably a misreading for dhái or dháwí gum (Grislea tomentosa). The

G. tomentosa is called dháí, and *Conocarpus latifolius*, dháú or dhoñi, as if one was the male, and the other the female in the ideas of the natives; hence perhaps the confusion of the gums.

Salhé or saláí is said to be a name of a kind of gúgal or balsamodendron (*Boswellia thurifera*), which is found in the Bengal hills and Rájputána, and to within 20 miles of the Bombay Ghâts.

Then we come to the PSEUDO GUMS which are insoluble.

STERCULIA.—The Burmese species (chiefly valued for bark fibre are :—S. *ornata* (shaw-wáh), S. villosa (shaw-ní), *S. fœtida* (shaw-byú).

MORINGA (*sohájna*). Authentic samples from various localities are much wanted; but there must be no doubt about the tree—everybody knows it—specimens of the tree to authenticate the gum required.

BOMBAX (*Salmalia*), sembal or simal tree.—This very doubtful gum could finally be cleared up by foresters. Every one knows the cotton-tree, *Bombax heptaphyllum* (*B. malabaricum* in F. Flora). Will some one really get gum from it beyond all doubt? At present we are divided between dull red gums like sohájná, &c., and a sort of hollow blackish shell like a *gall* or similar excrescence.

MOCHRAS is also one of the undetermined substances. Those in Burma and elsewhere also as near areca gardens would be able to tell us whether the areca has a *gall* on it. "Phúl-supyárí" is a name signifying "areca-flower," and given by druggists to the gall-like substance called mochras.

Butea frondosa (dhák or pala s.)—This it is noted has *good timber!* The wood is probably more worthless than any other known tree; it dries down to ⅓rd of original weight, and is used for making scabbards of swords, &c. In what provinces is kino or "kamar-kas" collected?

There is a creeper or climbing species of *Butea* in the Bengal Terai, which when cut across gives out a copious exudation of red juice.

The part of the report treating of gum resins, both medicinal and fragrant, and on soft or elemi and hard resins is full of

interesting information : the articles on Gamboge (pp. 41—49), Asafœtida (50—57), and on Amoniacum and Galbanum being specially full and exhaustive. In the article on Asafœtida however there is a passage which it is not easy to understand.

There are two substances in Bombay, one of the color of treacle in large masses enclosed in cowhide ; the odour is different from that of the European drug, and is much more powerful. It would appear that this is called "hírá hing," while the common asafœtida is called "hingra." Thus we read :—

"The substance known as asafœtida in Europe, is called hingra in Bombay; it is not used as a condiment, and is considered quite a different article (*i.e;* from hírá hing), it is exported to Europe. There is great difference in price. Hingra is about Rs. 7 a Surat maund, and asafœtida about Rs. 45." This passage as it stands is unintelligible—perhaps it means that asafœtida costs Rs. 7, and that the hírá-hing (a substance *not* known in Europe as asafœtida) costs Rs. 45.

Opoponax.—The origin and meaning of the native names of this drug will be found in Punjab Products, I, pp. 402-3.

Similarly interesting are the articles on Fragrant Gum-Resins, Myrrh, and Olibanum.

But all trees yielding gúgal or kundar in India want carefully collecting both the gum resin and specimens of the tree, with localities.

It strikes me that the species are confused. *Balsamodendron Roxburghii* perhaps gives the Bengal gúgal, and possibly most of the Indian gúgal. Then the Sindh species is called *B. mukul*, and another species *B. pubescens* is also said to grow in Biluchistan. It is not likely that the Sindh or Biluchi species would be common in Bombay and Central India, yet with *B. mukul* are given a variety of Hindi and Central Indian names. Should not these rather refer to the *Boswellia thurifera (B. glabra,* Roxb.), which would seem to be the source of the salhé of N. E. Bengal, and the sálaí of Bombay presidency? The "*Palamore* forests" referred to at p. 81 probably means "Palamow" (as usually spelt) in Bengal. The salhé (or salái?) is said to be abundant all about the Rájmahál hills.

With regard to the mango gum resin, it will be possible to enquire further about the Delhi specimen which was sent distinctly labelled to the Exhibition at Lahore in 1864, and answered to the description given in Punjab Products (p. 416.)

The very full and interesting papers on OLIBANUM constitute one of the chief features of the volume. The relation of salhé to this substance has been already touched upon. *Boswellia thurifera* has its habitat given as "tropical India." It should rather have been Bihár,* the Dakhan to within 20 miles of the Bombay Ghâts, Bandalkhand, Rájputána, the Central Provinces, and in sub-Himalaya as far as the Sutlej, also in South India. BRANDIS says that it grows chiefly on hot arid hills more or less gregariously, forming open forests often associated with *Sterculia urens*—particularly abundant on the trap hills of the Dakhan and the Satpúra Range. It is common also in the Rájmahál hills.

PWAI-NGET.—There is no sort of doubt that the proper substance described by this name in Burma is the resinous nest of the little bee, *Trigona læviceps.* I have collected pieces myself in hollows of trees in the forest, and watched the bees making the nest. They chiefly collect resin for the purpose (when I saw them in Pegu) from the *Dipterocarpus tuberculata.* (Eng.)

It is quite likely that their nests vary according to the kind of resiniferous trees common in the neighbourhood. It is also likely that bazar specimens would show the name applied to other resinous substances, or to the true substance worked up or melted down with some admixture. Will MR. KURZ tell us about this? and whether the *Canarium strictum* is a Burmese tree, and what the Burmese black or dark resin giving species (officinal) are?

Little remains to be added to the exhaustive account of the COPAL (sundras commonly also called "kahruba" or amber). This resin (erroneously referred to *Vateria* in Punjab Products, p. 410) is derived from the euphoniously named *Trachylobium Mozambicense* (Peters). The papers by the Assistant

* *Vide* Hooker's Trav. in Himalaya, Vol. I., p 29, where it is said that in the Bihâr hills at 1,360 feet, "the gum celebrated throughout the east was flowing abundantly from the trunk, very fragrant and transparent."

Political Agent at Zanzibar, reprinted in the *Indian Forester* for July 1875, do not appear to have been seen by Dr. Cooke.

There is also a recent paper read before the Linnæan Society (April 20th, 1876,) on the fossil copal found on the east coast of Africa in places where no copal tree now grows. Little doubt exists as to the identity of the semi-fossil tree with the living species, inasmuch as parts of the plant have been found preserved in the fossil resin or animé.*

PISTACIA.—Two species yield mastich. In Sindh (which country people will insist on " —— " and calling Scinde) the resin is called " honey of kundur," or simply " resinous honey," shaht-i-kundru. The Arabic names 'Alk-ul-anbat and 'Alk baghdad are hardly recognizable as *Auluk dagdadie* (*sic*) and Aluk-ool-unbat.

DIOSPYROS.—Something wrong here. The species would seem to be as follow :—*D. melanoxylon*, Roxb., not mentioned as a resiniferous tree and very unlikely.

Then also we have *D. montana* in India (not in North or Sindh), also *D. chloroxylon* (S. India as far as Orissa on the east, and Guzerat on the west coast), *D. lotus*, the fruit-bearing N. W. Punjab species (" amlok"), and *D. embryopteris* (*E. glutinifera*, Roxb., *D glutinosa*, Koenig), the gáb of Bengal, South India, and on the western coast, Ceylon, Burma, Bengal, Banda, and sub-Himalaya as far west as the Jumna.

The viscid pulp of the ripe fruit is used as a gum in book-binding and in place of tar for the seams of fishing-boats—an extract containing much tannin is made from the fruit (see *Brandis' F. Fl.*, p 298). This fruit is called kendú in Assam apparently, but kendú and tendu are names usually given to *D. melanoxylon* which has the heart wood black, and is used for ebony. If the fruit is meant in the text, we have neither gum nor resin properly so called to deal with.

MR. GUSTAV MANN will probably be able to enlighten us on the subject.

At pp. 106-7 a series of " Inquirenda" are given, to which it is sufficient to invite attention.

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* *Vide* Pop.'s Science Rev. for July 1876, p 320.

No. I regarding the "Moal" of Sylhet will probably be answerable in Bengal.

No. IV.—Officers in Burma and Madras could probably discover.

No. V has been alluded to already.

No. VI is a question for residents in the Andamans.

No. VII.—Bengal officers could settle.

Under the head of Kunnee, (Kani), p 110, the Odina question already alluded to crops up again.

And a question is asked about a Bombay (?) resin called māl shakshi.

It is no wonder that the Vienna exhibition samples turned out so badly. The whole business, as far as my knowledge goes, might be described as a perfect humbug.

When will committees charged with such affairs understand that, with the heavy work Indian officials have to get through, the distances to be travelled, and the difficulties of identifying species, good collections cannot be got together without *at least* a year's or eighteen months' clear notice? At the eleventh hour orders come; people hastily get together what they can, and the result is often unsatisfactory, if not useless. Of course, this is still more the case with manufactured articles which are rarely or never kept ready-made (especially the better class of articles), and any rubbish that can be found in the bazars is collected and sent. The wearisome delay in getting remittances of proceeds, discourages sadly the poor manufacturers of Indian goods, and only a few wholesale merchants, who do not produce the best work, send goods. European exhibitions as hitherto constituted, are a positive abomination. That of Paris in 1867 formed a tolerable exception.

The last group (oleo resins) has two divisions; *A.* balsams, *B.* varnishes.

First comes the *Balsamodendron Berryi*, whose extraordinary Arabic name "a qovoyalásamun" appears to me to have been formed by a misreading of the Arabic letters imperfectly pointed: q (the double-dotted "kat") being mistaken for the single-dotted similar form "fé" and "ye" for "be." This word is possibly

afáwa-balásamún; the Arabic form in Yunáni medicine of "opo-balsamum." My impression is that this druggist's substance known as "raughan-i-balsán" is usually an *artificial* liquid thick solution of one of the scented resins. *B. Berryi* is a South Indian species certainly.

Dipterocarpus.—Wood-oil is certainly obtained in Burma both from the "Eng" (*D. tuberculata*), and Kanyin (*D. turbinata*): but most, I believe, and the best, form the latter.

Camphor.—It is interesting to see that the common Hindustani name for camphor "kápúr" is a Malay word.

The liquid styrax is unknown to us here; but on what authority does Dr. Cooke give the plane (*Platanus orientalis*) as a synonym for the *Liquidambar orientale* of Anatolia, &c.? The plane is an introduced tree, and has only a naturalized Persian name "chinár," and a Kashmere name "búín" (the tree has very long been established there; one grove dates A.D. 1588.) Nothing less likely that any resin or oil should be obtained from it.

Melanorrhœa.—For an interesting account of the method of extracting this substance, see Mr. Brandis' paper on some forest products of Pegu in the *Indian Forester* of April 1876. I cannot understand how this substance, seing its beautiful application in Burma, is not more appreciated in England.

Again under this head the ill-fated *Odina wodier* appears: who ever obtained a varnish from this tree? The authority is the "Bombay Products."

Will Mysore and Belgaum district Forest officers ascertain if Buchanania Latifolia yields a varnish? (chironji is the fruit kernel: chirauli, &c.) Brandis says that a pellucid *gum* exudes from wounds in the stem, and an oil is obtained from the kernels of the fruit (F. Fl., p 128).

Rhus vernicifera.—The Japan varnish tree is said to be the same as a small species in the Himalaya (rikhálí, *gadúmbal* loháska, &c.), certainly we have nothing that yields a varnish. Brandis follows Decandolle and Royle in uniting the Indian tree with the Japan varnish tree, but feels assured the species are distinct (F. Fl., p 120.)

TURPENTINE AND TAR.—We have recently been selling tar from the chips of *P. longifolia* in our Kangra forests. It costs us Rs. 2-8 a maund=80lbs. to make. No one has, I think, yet attempted to distil spirit of turpentine. The crude resin of *P. longifolia* is beautifully clear in pale yellow tars as it exudes from the wood.

Both the pines *P. longifolia* and *P. excelsa*, as well as Deodar chips, make good tar by the same process.

The great difficulty of our making any profit out of such substances is the cost of carriage.

ABIES is one of the least resinous of our conifers, and no one uses it except for a local application to sore backs of cattle, for which purpose a tree (outside reserved forest let us hope) is ruthlessly notched. *Picea Webbiana* in the same way.

TEAK-OIL.—Burmese officers would probably have a good deal to add to the information given at p. 129.

In conclusion, I hope, some officers whose eye catches their own names, or the name of a province they know, will communicate with this periodical on the subject of the many "inquirenda et disputata" of the Report.

The Ficus Elastica in Burma Proper, or a Narrative of my Journey in search of it.

By G. W. Strettell.

The journey in search of the Ficus elastica in Burma proper lasted from the 22nd November 1873, until the 13th May 1874, and now after two years have elapsed, we are favored with the results of the "*mission*," as the author calls it. One would think that the report on a simple little trip in search of India-rubber might have been printed and published in less than two years, but some how or other India seems to *be the land of delays*. That the Government work does not gain by those everlasting and ever-recurring delays is self-evident, and it is really difficult to understand why they are allowed to take place. Our author gives a long explanation in his case, but we think delays like that in question cannot be satisfactorily explained.

From page 3 of the book we see that the original object which has given birth to the book, was as follows:—"To form "Ficus elastica plantations in British Burma, and to ascertain "the best method of working them. To facilitate this object "our author was *directed to proceed at once to Upper Burma* "and examine the forests there, making himself familiar "with the general habits of the tree, the soil, and locality best "suited to it, the different methods of tapping, and the various "systems pursued, in order to bring about the coalescence of "the caoutchouc."

The India-rubber trade of Upper Burma has sprung up during the last few years only, wherever it has existed in Assam and Cachar for many years past. In Assam large Ficus elastica producing tracts are situated within British territory, and any officer can study the habits of the tree and the mode of working quite at his leisure, and without any particular danger. In Upper Burma, on the other hand, the India-rubber forests are situated beyond the reach of any authority, except that of lawless mountaineers, and any attempt to study here the habits of the tree would be coupled with great risk of life, if not altogether impracticable. Hence it appears to us difficult to understand, why Mr. Strettell was not sent to Assam, instead of to Upper Burma, if the "*mission*" was considered necessary at all.

We should think it was not necessary, because not only have we already in print as much information on the subject, as Mr. Strettell was likely to gather under the most favorable *circumstances; and secondly* we consider it very doubtful whether Ficus elastica plantations are indicated in British Burma. While the latter is not the natural home of the tree, Assam is. Moreover, in Assam any amount of land suitable for plantations is available, and labor is about half as expensive as in Burma. Considering all these points, and also that it is perfectly irrelevant in what part of India the caoutchouc is produced, we do not understand, why the Government should spend *Rs. 18,000 in sending Mr. Strettell* to Upper Burma, and letting him print afterwards at Government expense a large book on his "*mission.*"

However, if Mr. Strettell had succeeded in his "*mission,*" there would be some return at least for the outlay; but what was our surprise on finding, after wading through 207 pages of print, that Mr. Strettell never got to the real India-rubber forests, but turned round after he had seen one or two outlying patches. The consequence is that the book four beginning to end contains nothing new as far as the Ficus elastica is concerned, but a great deal extracted from books and reports which were already at the disposal of any one who wished to inform himself on the subject.

We need not add many more lines to bring our review of the book to a close. As stated above there is nothing new in the book regarding the Ficus elastica. On the other hand, as a book of travel it is not uninteresting, but we must leave a review of the book in that respect to those into whose department it legitimately belongs.

Sw.

B. H. B.-P.

A few Notes on "Suggestions regarding Forest Administration in British Burma."

BY D. BRANDIS, F.R.S., *Inspector-General of Forests to the Government of India.*

IN admitting that no one is better competent than Dr. Brandis to grapple with the difficulties which beset Forest administration in British Burma, it is not necessary that one should go the length of agreeing with him in each and all of his proposals.

I purpose confining my criticism to a few points only, and firstly to the fundamental position advanced in para. 18 of the pamphlet, on which it is presumed Dr. Brandis has based all his proposals for the settlement of rights. Dr. Brandis argues :— "All unalienated forest land in all other parts of British Burma is, with all the products growing upon it, the absolute property of Government, subject to such prescriptive rights as may have been acquired by the agricultural population in the vicinity of the forests. This right of Government is proved sufficiently, if proof be needed, by the grants made some years ago under the waste-land grant rules, under which

large areas of waste and forest have been disposed of without reservation." Now here it is very difficult to escape the conclusion that Dr. Brandis, while he wrote, was preparing himself for the sacrifice of principle to expediency, and that in his anxiety to temporise, he has committed himself to a paradoxism. If the instance adduced, the sale of forest lands, without reservation, proves anything, it proves that the Government held itself to be the absolute proprietor of the land, *untramelled by any obligation to the villagers,* who, if they had possessed legal rights in the alienated forests, could have prevented the alienation, or claimed a share in the proceeds.

The fact is, it appears to me, that the Forest Department by its demands for absolute authority over the forests, has provoked the District Officers to the support of forest rights as against the Department.

It is not my intention here to enter into the desirability of conferring rights in our forests, nor to argue whether the rights of District Officers are beneficial or otherwise in their exercise, but what I do maintain is that the Government of India is the sole proprietor of its forest, except in so far as it has vitiated the position by recent legislation, and that the question of conferring further rights, is one solely of expediency and to be treated as such, if we are to avoid paradoxes in the discussion of the question.

If this view is wrong the Government has rendered itself liable to actions for every acre of forest land it has alienated without the consent of every third party having rights in such alienated lands.

The general scope of the "proposals" is the division of the forest area of Burma into three classes: 1*st.* State forests to be under the control of the Forest Department, but subject to certain rights of neighbouring villagers to be formally settled and registered. 2*nd.* District Forests in which for the present the timber trade shall be under the control of the Forest Department, while the permits for all timber for local use (free permits), together with trade permits for charcoal, cutch, and wood-oil, should be granted by the Civil Officer on payment (the revenues from these sources being credited to the

Forest Department); ultimately (after the first class of forests shall have been demarcated) it is proposed to vest the control of these forests entirely in the hands of the Civil Department. 3*rd*. Communal or village forests, to be administered by the State for the benefit of the villagers.

The proposals for the management of District Forests appear to me to merit further consideration. It is a cumbersome method to have two departments granting permits in the same forest, each sending the other the counter-foils; it would be costly to maintain a double staff of officials when the duty could be performed by one—it would be inconvenient to traders to have to go to the Revenue Officer for their permits for charcoal or cutch, and to the Forest Officer for their timber, and hardly possible but that with two Forest Chiefs, each independent of the other, there should not be some clashing, indeed Dr. Brandis appears to have recognised this later on, for in para. 29, after hinting at the necessity of placing Forest Officers in a more definite relation to District Officers, he advocates the Forest Officer falling into the position of Assistant to the Deputy Commissioner, and especially in District Forests.

The first proposal has little to recommend it. If it is determined to allow certain villagers to exercise the right of felling all but teak timber for their own requirements, it is rarely necessary or profitable to hamper all parties with permits.

It is only necessary to notify to the Forest Department that the Government has been pleased to make certain concessions, and the Forest Officer may be relied upon to give effect to his instructions. The District Officer, with his multifarious duties, has far less time than the Forest Officer to devote to the matter, and no good purpose whatever can be attained by empowering the former to issue either free or trade permits for forest products. It is quite sufficient that his magisterial powers enable him to take cognizance of any complaint on the part of the villagers that any obstacle is thrown in the way of their availing themselves of the privileges conceded them by the Government. Dr. Brandis does not even attempt to argue that any advantages are likely to flow from the proposal, and I can

only regard it as a half-hearted and inadequate attempt to conciliate the District Officers.

The next proposal that, after the demarcation of the State forests, the remainder constituting the great bulk of the forest area shall be administered by the district authorities, aided by Forest Officers, to be attached to them as Assistants, is hardly more satisfactory. These Assistants would frequently be young men wanting the experience of their departmental seniors to guide them; but Dr. Brandis perhaps purposely made his remarks on this subject suggestive only preferring that definite proposals for the general subordination of the forest executive to the District Officers should emanate from the latter or the Chief Commissioner. The proposal, as it stands, would still be unsatisfactory to the District Officer, as it would exclude him from any voice in the administration of the State forests in his district. Moreover, the mere fact that some forests are to be cumbered with heavier rights than others, is no adaquate ground for placing their administration in the hands of two separate departments. They are all State Forests; it is to the interest both of the Government and governed, that the administration of all alike should be vested in the most competent hands, and the advantages of treating them all uniformly as a valuable State property are of far more importance than the minor question of whether Forest administration should continue aloof in its own independent groove, or be merged in the general administration of the country.

I am disposed to advocate *this total absorption of the* Forest Department in Burma, firstly, because its immediate results will be to render the whole forest area State forest without distinction; secondly, because I am strongly of opinion that to vest District Officers with the responsibility of Forest *administration, will be to ensure the examination of every* question as it arises from the Forest Officer's stand-point as well as from their own.

The details of the scheme present no practical difficulty—there would be a Deputy Conservator or Senior Assistant in *charge of the forests of each district, receiving* his instructions

from the District Officer only, but subject to the periodical visitation and counsels of the Provincial Forest Chief who would be constituted Provincial Inspector-General; and the extra allowance, which Dr. Brandis suggests for those Assistants whom he proposes to transfer to the charge of District Forests, might advantageously be made to depend on their qualifying themselves for magisterial duties. Thus qualified their leisure during the rainy season could be profitably employed, and their sphere of usefulness would be enlarged to the benefit of the State, and necessarily to their own.*

BLACKTHORN.

Punjab Plantations.

DEAR SIR,—An extraordinary statement which appears in your number for July 1876, page 69, where, in reviewing the General Forest Report for 1873-74, you say that the area of Punjab plantations was reduced by 7,872 acres *abandoned;* "which may be considered equivalent to an acknowledgment of previous mistakes."

This is not at all the case.

The total area of plantations shown at the beginning of the year was 21,970 acres, in which by some strange mistake the area of the *Reserved forests*, Kalatop and Bukloh, had been included. To deduct from the *plantation's* schedule the area of this forest (7,680 acres) was only to correct the error; it involved no abandonment of anything.

The plantation area, correctly stated, gives us 21,970—7,680=14,290 acres. During the year 1,452½ acres (extension) were added; a loss of 165½ acres occurred by river erosion; this, with the correction of certain errors in areas previously "estimated," left the total at 15,550½ acres.

A part of this area represents replenishments of existing forest (where reproduction had to be aided), and should not, in my opinion, be shown in a statement of artificial forest or

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* Fortunately there is no danger of Government acting on Blackthorn's suggestion for some time to come.—THE EDITOR.

plantation area ; but that has nothing to do with the question of abandonment.*

Yours faithfully,

B. H. BADEN-POWELL,

Consr. of Forests, Punjab.

SIMLA, 14*th September* 1876.

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* We heartily apologize herewith for our mistake in the July number.—THE EDITOR.

III. Notes and Queries.

Acrocarpus Fraxinifolius.

THIS curious leguminous tree is one of the largest of our forest trees in South India. I have seen trees fully 200 feet high and 150 feet to the first bough, often of immense girth and with large buttresses, it is also a most valuable timber much in use for building purposes and for shingles, it is known to Europeans as the red cedar or shingle tree, and is called Malay yembu, Malay kone, and kilingi by the natives in different parts ; its legume is not described, for owing to the great height of the tree, there was much difficulty about procuring it, and I only succeeded in getting specimens this season, it is long stipitate, dehiscent, 3—4 inches long by ¾ inches broad, with a short curved beak at the apex, and a broad wing along its upper margin, flat compressed and rather coriaceous, 4—7 seeded. I procured abundance of seed, some of which is being tried at our Nelambúr plantations, and the rest was forwarded to the Bangalore and Ceylon gardens, so it is to be hoped that the tree will be brought into cultivation ; it grows in all our western forests from Canara down to Cape Comorin, and is found from low elevations up to above 4,000 feet, and though it generally affects the moist evergreen forests, it is often to be found outside of them and in bamboo tracts ; its introduction to other parts of India is well worth the attention of Forest Officers.

R. H. BEDDOME, *Lieut.-Col.,*
Consr. of Forests, Madras.

OOTACAMUND, *29th June* 1876.

Beesha Rheedii.

THIS most interesting bamboo is, I believe, figured in Rheede's Hort. Mal., though I have not his work to refer to. I have been looking out for it since 1857, and though I have constantly passed through acres of it, I have never

noticed it till this year, the fact is it has never flowered since till this season, and bamboos are very much alike unless in flower, and I have never carefully looked at any unless in that state. Going down the Sispara Ghaut on the west slopes of the Nilgiris this year in May, I came upon it abundantly in flower and fruit, and obeserved hundreds of acres of it dead and dying out; it has certainly not flowered since 1857, so its duration is certainly 20 years, probably 25 or 30, and it dies down after flowering. I have collected quantities of its large egg-like berry which is quite similar to that of Beesha Travancorica (figured at plate CCCXXIV of the Flora Sylvatica), and as I have distributed them to the Lal Bagh gardens in Bangalore, the Peradenia gardens at Ceylon (and thence through the kindness of Mr. Thwaites to Kew I hope), and to the Calcutta gardens, it may, I trust, be brought into cultivation. It was first observed at about 4,300 feet elevation, and extended down the Ghâts to about 2,800 feet when its place is taken by Teinostachyum Wightii. It is not quite such a grand species as Beesha Travancorica (which is now in cultivation in Ceylon). Munro's description (taken probably from Rheede's figure, I have not the monograph at hand), as quoted in my Flora Sylvatica, if in reference to the same species which I think it must be, is not quite correct, the bamboo now alluded to has 30—40 stamens which are quite free, anthers not apiculate, stigmas 4-5 not twisted, paleae suddenly mucronate, leaves $1\frac{1}{2}$ to $2\frac{1}{2}$ inches broad; sheathes very hirsute when young, and with very long white *ciliæ at the mouth, and with a long terminal* beak at the apex. Good dried specimens have been forwarded to Kew.

Since writing the above one of my officers has received flowering specimens of this from Mr. Griffin, a coffee planter in the Ochterlony valley, with a note that he has been watching it for 20 years, during which time it has never flowered, that it is of the greatest utility on his estate (3,000 feet,) and that he now fears it will all die out.

R. H. Beddome, *Lieut.-Col.*,
Consr. of Forests, Madras.

Ootacamund, 29*th June* 1876.

The Forest Department in Madras.

THE heavy indictment against the Madras Forest Department, which we reproduce below from the *Pioneer* of August 15th, 1876, will not, we hope, be received by the Madras Forest Officers with resentment, but as a welcome opening to a decided and powerful move on their part. It is not, we are confident, the fault of the Madras Officers that the forests are undemarcated, are destroyed without check, that the reports repeat year after year the same sad story of fires, cattle-trespass, and waste: nor is it their fault that the forest finance is in an enfeebled condition, and that hundreds and thousands of rupees are annually converted from Imperial revenue to local purposes, and do not appear in the Forest accounts. It is the fault of the obnoxious system which places every Forest Officer in subjection to the Collector, the relation being at once unsatisfactory and undefined. There is, as yet, no recognition of the principle that, if forest divisions can be made to coincide with civil or fiscal ones, and a Forest Officer placed in each subordinate to the civil authority, it is a good thing in various ways; but that is essential under such circumstances, that the forest area should be determined, and the professional principles on which its management and exploitation rest, should be determined, and should be followed out solely under professional supervision.

It is time really that the Madras Government should insist on a demarcation of forests* to be preserved either for the State or (where that is not possible owing to the wants of the people) for the use of towns, villages, and communities, but in either case to be preserved, and a fixed yield taken from it according to its capacity. All professional matters regarding the treatment of the area so demarated should then be directed responsibly by the Conservator of Forests.

All forest income should be openly credited to Imperial revenue, and no expenditure made against such income, but what is legitimately connected with forest work.

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* It is commonly believed that the action of Government is likely to cause the loss of the whole of the forest area of Kanara.

It is very much to be rejoiced in that the Public Press in India is beginning to take up forest questions in an enlightened spirit, and to appreciate the immense economic importance of our forests, not only as a set of live timber yards, but as features in the natural organization of the country, which can no more be safely disregarded, than can the important functions of roads, railways, drainage works, or rivers.

The *Pioneer* doubtless did not forget the work already done in Madras; the fine Nelambúr teak plantation, which is now extending by a small area every year, and the successful plantations of Eucalypti in the Nilgiris (though of insignificant extent; only 930 acres about), and the satisfactory financial results that these have shown.

But these successes in so large a territory and over such a number of years, poorly compensate for neglect elsewhere in the work of placing under proper treatment sufficient areas of natural forest.

With this brief preface we leave our readers to consider the article in question, and hope that it will elicit from the Madras side a frank discussion in a friendly spirit, remembering that it is an attack on the system, not the men, and is designed to help in correcting errors, not to hurt professional or official feeling.

From the Pioneer of August 15th, 1876.

"Forest conservancy in Madras appears to be in much the same position as it is in other presidencies. There is a regular department, and the officers in the department receive yearly praise for the way in which they do their work. But nothing is known about the actual resources of the forests, and very little is done to mark off new reserves, or to preserve existing ones. The Government of India have recently expressed a strong opinion as to the necessity of determining once for all the forest tracts which should be reserved, and to acquiring in them absolute ownership on behalf of the State. In Madras the forest land is very extensive. The Board of Revenue mention ten forests, the united area of which is estimated at between 5,000 and 6,000 square miles. No information whatever is said

to be available for the other forests. The question of a survey has long been mooted, but nothing has yet been decided. At present there are little more than 100,000 acres of "reserves," and the plantations are not very flourishing. If wood plays the important part in the economyof India, which it is supposed to do, every year's delay to effectively conserve selected areas of forest will entail serious consequences in the future. More harm can be done by cattle, and the wanton felling of timber by villagers, in one year than it is possible to repair in ten. To take one instance out of hundreds. The base of the Nilgiris is fringed by low acacia forests. Every year, says the Deputy Conservator of Mettapoliem, thousands of satin wood and other valuable trees are lopped and felled in the hot weather to feed the large herds of goats which natives keep there for supplying the hill market with meat. Native *shikaris* also do a great deal of harm. The *Deputy Conservator found on one occasion a fence,* half a mile long, "constructed with satin wood and ebony, and other valuable saplings, with staked gaps every ten yards for impaling deer. In their periodical hunts, they fell lanes from half a mile to a mile long, cutting down everything in their way, and setting nets for deer in the gaps." This irreparable destruction of timber goes on everywhere in India, unless stringent protective measures are in force. Sooner or later the country will wake up to the unpleasant consciousness that its natural wealth of wood is not inexhaustible, and wish when too late that the evil had been grappled with in earlier days."

Contents of Air and Rain-water.

The following is form *Nature* (June 15th, 1876):—

NEW METEOROLOGICAL LABORATORIES AT MONTSOURIS.

M. MARIE' DAVY, Director of Montsouris Observatory, has organised, partly at the expense of the French Government, partly at the expense of the city of Paris, a chemical and microscopical laboratory for the analysis of all the matters in suspension in the air of Paris, both quantitatively and qualitatively. A certain quantity of air is constantly aspired by an aspirator in continued operation. The ozone acting on iodide

of potassium and starch liberates iodine. The quantity of ozone liberated is measured by a titrated solution of arsenite of sodium. The matters in suspension are collected on a glass plate, and the crop is placed under the object-glass of a powerful microscope magnifying 1,000 times. The principal forms are drawn, and plates are executed and published monthly in the transactions of the establishment. The analysis of rain-water is conducted on the same principles, and the results of chemical analysis are calculated and compared with the wind and other atmospheric circumstances.

We are indebted to M. Marié Davy for the principal results of the month of February, the first period for which the whole system has been put into complete operation.

The electrical department has been fitted up, after a preliminary trial, and has been in working order for some time. In order better to illustrate the importance of these researches we take the liberty of altering the figures in order to give the results in round numbers for the whole area of Paris within the fortifications. The surface is about 80,000,000 square metres. In February 1876 the quantity of atmospheric water was 4,500,000 cubic metres. This is about double the average, but in some years on record the quantity was even larger, in 1776 a century ago, it was more than 6,500,000 cubic metres. In taking as an average the analyses of rain-water at Montsouris, the 4,500,000 cubic metres contained 4,700 kilogrammes of nitric acid, and 10,700 kilogrammes of ammonia. This mass of nitric acid is supposed to have been produced by electrical reactions in the atmosphere, and ammonia only partly, as Montsouris is in the southern part of the city, close to the fortifications.

The 4,500,000 cubic metres of rain-water were also proved to contain 172,000 kilogrammes of organic matter, and 88,400 kilogrammes of metallic salts or products. A number of organic matters have been found to be composed of spores, parts of animalculæ, and even living infusoriæ. Amongst the metallic salts we must mention particles of meteoric iron, evidently of cosmic origin. It is contemplated by the city of Paris to establish similar observations in several parts of the city, and the

careful comparison of these analyses will prove invaluable for establishing a number of most interesting facts having a bearing on the welfare of inhabitants, as well as on the elucidation of important scientific problems.

It is also comtemplated to make use of aëronautical ascents to test the air at any altitude accessible to a balloon with horizontal glass plates covered with glycerine. The moisture of the clouds is to be condensed on glass tubes which will be refrigerated.

The ozone testing and measuring has produced also startling facts. Although the quantity of ozone is very minute, amounting to only a few milligrams per 1,000 cubic metres, it has been proved that on February 27, the day of the ozone maximum, a quantity of 900 kilogrammes was floating over Paris, if we suppose that the quantity was the same as at Montsouris in the whole stream of air passing above up to the altitude of 1,000 metres.

These results are only a sample of those which may be expected from the constant application of the magnificent system which is now brought into operation for the first time, and of which it will be possible to say, *Vires acquirit eundo.*

Rats.

Sir,—In reply to Mr. Sparling's query in the July 1876 number, I have heard that the stinging hairs which cover the pods of *Mucuna pruritis* * ("cowitch" or "cowage"), if mixed with soil near roots of plants, drive away rats. So does cayenne pepper: but whether this would retain its qualities *long enough*, if put in the soil, I cannot say.

For seeds and (possibly roots?) moistening with kerosine is a preservative, and it is said not only to do no harm to germination and growth, but positively to aid them.

I do not answer for any of those ideas, I only throw out what I have heard for further enquiry or trial.

Yours obediently,

J. K.

* This seems in India the *seeds* sold by druggists under the name of kúnch gûnch, gûnch-gají or kawanch.

On the Effects of grazing in Sal Forests.

IN the July number of the *Forester*, W. has dealt most summarily with my notes in the April No. on the effects of grazing in sal forests.

I readily admit that my statements were opposed to the experience of foresters, and that grazing is generally the greatest enemy to forests; but as in the case in question it checks the growth of the high grass, which in Assam has hitherto rendered our attempts at forest conservation unavailing, I have thought that some further notes might be permissible.

In the first place, my former notes should only apply to forests in the Eastern Doars, and those under similar conditions of humidity and soil. I have noticed the same effects in Kamrup, where the cultivations are frequently surrounded by splendid young sal.

It has been proposed to render all grazing illegal in the Eastern Doars; now if this provision were enforced cultivation near, the sal forests will be checked, and the cultivators will remove to a distance, leaving the forests to be surrounded by a howling wilderness of grass, which will be a nest for jungle fires. As our sal forests in the Doars constitute an area of nearly 400 square miles, we can afford to give up all surrounding grass land, and a well-stocked forest, with cultivation up to its boundary lines, is the ideal to be looked for. Now if it be found that the best forests are near cultivation, and if cultivation up to and grazing within the edges of the forest prove a check to fires, the District Officer and the Forest Officer will be better friends, and a class of wood-men, as are the Mechis, will not be driven away from their old quarters, but will be on the spot for any forest work which may be in hand.

The Sidli forest, referred to in the April No., contains about fifty square miles of nearly pure sal forest, with large patches of grass land, and with lower hill forest along the water-courses.

Cultivation has penetrated into the forest, and rice is grown on land artificially irrigated, the forest having been jhumed for

cotton cultivation, but not since the country has been annexed from the Butias. To this jhuming and to excessive felling the introduction of an undergrowth of grass, which grows up to 6 or 8 feet in height, has been due; only round the villages and their cultivations is the forest free from this grass, and here it is generally remarkably good as described in the April No. of the *Forester*.

The grass in the forest is full of shoots of burnt seedling, which are destroyed every year when the fires rage through the forest burning the trees up to the topmost leaf, except where the lower hill forest, or the close growing blocks near the villages, stop the progress of the flames.

The Mechis change their villages every three or four years, they settle in open grass land near a piece of sal forest to shade their houses. This sal forest is of course thin like the rest of the forest full of coarse grass, and not as assumed by W., so free from grass as to be comparatively safe from fire. Their cattle proceed to graze on, and trample down, the high grass in the forest near the village, so that in the dry season, instead of a uniform mass of grass, only high tufts are left here and there, the rest of it being low. The seedlings and shoots are so abundant that, if some be trampled down, yet plenty are left to stock the ground and, being shoots from old plants which have been burned year after, they commence growing vigorously as soon as they are freed from the grass.

I do not believe that common cattle graze off sal seedlings, as I have watched them carefully, whatever buffaloes may do, and the latter are not kept by the Mechis, nor do wandering herds of buffaloes come near the Sidli forests, and they can easily be kept away without affecting the villagers at all.

In the course of a few years after the village has been established, owing to the shortness of the grass, the fires get less and less fierce, if they get in at all, and the young shoots, with accumulated force from the large roots which such burnt seedlings have, grow up vigorously.

The larger trees also lose their charred bark, and soon shew the effects of their changed conditions. As the young sal grows up, less and less grass appears, and the undergrowth of

evergreen shrubs is encouraged by the increased moisture in the ground.

In the block referred to in the April No. of the *Forester* burned stumps were in the ground, and it was evident that fires had prevailed at no distant period. The villagers said that it was seven or eight years since they had settled there, and that the grass was kept down by their cattle, and that this had put a stop to the fires.

When once a forest has attained to such a condition, as that no fires get into it, the presence of cattle is rather prejudicial than otherwise, but as there is in that case little for them to graze off, they will prefer the grass outside.

When W. assumes that the forest in question was originally in such a condition, he begs the whole question.

Also his suggestion that the clearing of unreserved trees by the villagers for fire-wood affords the sal seedlings more light, will not account for the improved state of things consequent on the proximity of cultivation.

In the first place, it is nearly pure sal forest; in the second any more light would favor the growth of grass in which the seedlings are already choked, and therefore increase the fury of the fires. W. also speaks about the light grass growing in deserted cultivations, but the Mechis do not leave sal trees in the middle of their cultivations, and when all trees have been felled, it is difficult to see how forest blocks with 150 trees to the acre, as shewn in my former article, can have sprung up.

I believe that in Sidli deserted cultivation in three or four years' time becomes covered with dense grass, and never returns to forest again owing to the fires. W. also wishes preventive measures dictated by common sense and experience to be tried, but as he admits that the efforts of Forest Officers in the direction of fire conservancy have been so unsuccessful, surely common sense can afford to listen to other plans.

Supposing that the trampling and grazing of the long grass acts as a nutriment, and irrespective of the check which it causes to the fires, that it frees the young plants from the grass, and lets in light, it is surely of benefit. It should also be mentioned here that sal being the natural forest of the

Doars, it is extremely hardy, and as soon as the fires are checked, that it grows up irrepressibly.

W. R. F.

On the Killing of Trees.

TO THE EDITOR OF THE "INDIAN FORESTER."

SIR,—I should feel much obliged if you would kindly insert the following letter in your October number of the Magazine:—

R. WHITTALL.

"With reference to F. B.'s answer to M. H. F. in the January No. of the *Indian Forester* for 1876, it is greatly to be regretted that F. B. has adopted a sneering tone in his remarks.

"It is difficult to quite understand what F. B. wishes to disprove: he would seem to say that scalariform vessels, by being *characteristic* of the higher division of acotyledons, *i.e.*, ferns and their allies, are *confined* to them, therefore that they do not occur in dicotyledons, and that therefore M. H. F. is wrong in saying that the diffusion of the azotized combinations take place through them.

"I may be wrong in my inference, but I need hardly say that, if this is what F. B. means, he is totally wrong.

"In the very work from which he quotes (Balfour's Manual), the illustration of a scalariform vessel is taken from a vine.

"If F. B. wants proof, I will refer him to Seubert, p. 121, fig. 420:—'Portion of a *dicotyledonous* vascular bundle—*a.* retiform; *b.* scalariform vessels.' Again, p. 128:—'Phanerogamous plants, in general, are distinguished by the presence of vessels and vascular bundles. Among cryptogamous plants, however, *only ferns and their allies are similarly characterized*, and are on that account designated vascular cryptogams.' Again, in speaking of dicotyledonous plants:—'The nitrogenous plastic combinations are contained in the liber, and principally in its retiform and scalariform vessels . . . . . . while the diffusion of the non-azotized nutritive substances takes

place in the parenchymatic tissue both of the bark and the stem.'

"Robert Bentley says, p. 49:—'These vessels (scalariform) are sometimes cylindrical tubes like the other kinds, as in the vine (fig. 106) and many other dicotyledonous plants, in which condition they are but slight modifications of reticulated vessels; but in their most perfect state, scalariform vessels assume a prismatic form as in ferns (fig. 105) *of which they are then specially characteristic.*'

"These I hope are sufficient to prove that scalariform vessels do exist in dicotyledonous plants as well as in ferns.

"I *fail also to see anything misleading* in the term 'hydrocarbon' which is, I suppose, what F. B. means when he writes 'hyrocarbon,' unless it be a clerical error. F. B. accuses M. H. F. of speaking 'loosely,' a criticism in which I cannot agree, but he himself places resins, excreta, as they may be called, in the same category with gums and starches, the assimilated combinations of C. H. O. (if this be 'admissible') actively concerned in nutrition.

"Nor does there seem to me anything in M. H. F.'s explanation which would lead one to suppose that he was under the impression that these were 'pumped out of the earth in a pure state.'"

R. W.

RANGOON, *July 8th*, 1876.

Budget Headings.

IT appears to me to be a mistake to put the expenditure incurred in re-stocking bare tracts under A. IV.—1. *Cost of Creation of Natural Forests.*—If the restoration of denuded areas is not considered sufficiently artificial to bring it under A. IV.—2, it is scarcely necessary to have a special sub-division for the cost of the creation of artificially formed forests, as the re-stocking of denuded areas is essentially an artificial process. The item comes naturally under A. IV.—2 *(a)*. *Formation of Artifical Forests* (or, more properly speaking, artificial formation of forests); but if it is necessary to distinguish between the

re-stocking of waste which has been denuded of trees within the memory of man, and that which has been bare for a longer period, it should come under A. IV.—2 *(e)* re-stocking of denuded areas.

JANGALI BULBUL.

THE

INDIAN FORESTER.

Vol. IV.] JANUARY, 1879. [No. 3.

Memorandum on the rate of growth of Teak.

By D. Brandis,

Inspector-General of Forests.

CONTENTS.

For the Manual of Indian timbers, now under preparation, it was necessary to bring together all information available regarding the rate of growth of Teak, and it appears advisable to circulate the results at once with the view of eliciting further data in order to complete the account that will be given in the Manual. The following data were brought together with the assistance of Mr. A. Smythies, Assistant Conservator of Forests, Forest School Circle, North-Western Provinces.

2. A brief account of what was known regarding the rate of growth of Teak up to 1873 was given on pages 357-359

of the Forest Flora of North-West and Central India. Since then, further data have been collected; but the chief addition to our information on this subject has been made by the publication of Colonel Beddome's Report of 1878 on the Nilambur Teak Plantations. The data here brought together in no way give a complete account of the rate and mode of growth of Teak, and doubtless much more information is available which has not yet been published. It is a most important subject, which should now be taken up separately in each province where Teak is cultivated on a large scale, and its study is earnestly recommended. The following remarks will most conveniently be grouped under the head of annual rings, girth and height at different ages, cubic contents of individual trees, and the number of trees and cubic contents of growing stock per acre. It will be remembered that the rate of growth of every species varies between wide limits according to climate, soil and numerous other circumstances which affect the development of trees.

3. *Annual rings.*—It is now established beyond doubt that the concentric rings which are so marked in the wood of Teak correspond each to one year's growth. The following statement exhibits the rings counted on sections of trees grown in the Nilambur Plantations, which were cut in 1877. The sections were taken from the base of the stem, and, with a few exceptions, the number of rings agrees with the age of the tree. The average diameter is the mean of three diameters. The statement shows the gradual increase of the heartwood as the tree grows older, and it also exhibits the number of rings on one inch of average radius in the wood of trees of different ages. But it must be borne in mind that these sections do not rep resent the average of each year's plantation, but were selected from among the dominant trees. They, therefore, exhibit a more rapid rate of growth than average specimens would do :—

Year of plantation.	Number of rings counted.	Average diameter of section (wood only.)	Average diameter of heartwood.	Rings per inch of average radius.
		In inches.	In inches.	
1844 ...	33	20·8	19·3	3·17
1845 ...	31	21·1	18·7	2·95
1846 ...	31	20·	17·7	3·10
1847 ...	30	23·8	21·5	2·52
1848 ...	28	16·7	15·4	3·34
1849 ...	28	18·1	16·2	3·09
1850 ...	27	14·	12·5	3·85
1851 ...	25	15·2	13·4	3·28
1852 ...	32*	15·2	13·5	Omitted.
1853 ...	24	15·1	12·	3·17
1854 ...	24	17·3	15·2	2·77
1855 ...	23	12·4	10·5	3·71
1856 ...	21	15·2	12·6	2·76
1857 ...	20	12·2	10·6	3·27
1858 ...	19	14·	11·3	2·71
1859 ...	18	14·	10·6	2·57
1860 ...	17	12·9	10·4	2·63
1861 ...	16	13·1	10·5	2·44
1862 ...	15	11·7	9·	2·56
1863 ...	14	13·6	10·4	2·06
1864 ...	13	12·5	9·4	2·08
1865 ...	12	9·4	6·9	2·55
1866 ...	11	10·4	7 3	2·11
1867 ...	10	11·8	8·3	1·69
1868 ...	9	10·5	7·6	1·71
1869 ...	8	7·4	4·8	2·16
1870 ...	7	7·4	4·5	1·89
1871 ...	7	7·7	4·3	1·81
1872 ...	5	6·5	2·6	1·53
				Average 2·62 rings per inch of average radius.

4. The sections ranged in age from 5 to 33 years. Dividing them into three groups, two of 10 years each, and the third of nine years, we obtain the following as the mean diameter in inches of these three groups :—

			Inches.
Mean diameter of trees	5—14 years old	...	9·72
	15—24 „	...	13·79
	25—33 „	...	18·71

* There is evidently a mistake here. The tree which yielded this section must have been an older tree standing in the plantation of 1852.

A section sent from the Thinganneenoung Plantation in Burma, cut from a tree 21 years old, planted in 1856, gave 21 rings on a mean diameter of 16·3″, the heartwood of which occupied 14·5″. This section showed 2·57 rings per inch of average radius.

5. From other plantations also, sections of Teak trees of known age were sent for the Paris Exhibition, but apparently they were not in all cases cut from the base of the stem; they are, however, instructive as showing the rate of growth and the number of rings on one inch of mean radius.

Year of plantation.	Number of rings counted.	AVERAGE DIAMETER OF SECTION IN INCHES.		Rings per inch of average radius.
		Wood.	Heartwood.	
SOUTH KANARA (PARAPPA PLANTATION).				
Not known ...	10	9·	4·9	2·22
" ...	5	5·5	2·5	1·81
NORTH KANARA (KALANADI VALLEY).				
Sulageri, 18 years old	18	8·	6·	4·5
	17	8·8	7·5	3·9
	17	9·	7·	3·7
Murdi, 12 years old	8	7·5	Heartwood not distinct.	2·1
	11	6·		3·7
	11	5·7		3·8
Kadra, 10 years old	8	6·5	...	2·5
	8	7·5	5·	2·1
	7	7·	4·	2·
BENGAL (BAMUNPOKRI).				
1868	8	6·5	2·5	2·5
1871	6	6·	1·	2·
1872	4	5·	1·	1·6
ANDAMANS (PORT BLAIR).				
1873*	6	10·1	6.	1·2

6. It will be noticed that, as far as the data go, which are furnished by the sections received, Thinganneenoung and Bamunpokri exhibit an increase of diameter similar to that of Nilambur; while in the samples from North Kanara the annual rings are much narrower, and the specimen from Port Blair showed an extremely rapid rate of growth.

Girth and height at different ages.—The following measurements illustrate the rate of growth of Teak in plantations in

*The tree was probably older.

different provinces as nearly as possible from 5 to 5 years. The Nilambur Plantation again furnishes the largest amount of information :—

Age.	Mean girth at breast high.	Total height of tree.
Nilambur Plantation.—Alluvial soil.		
3—7 years ...	12 inches ...	29 feet.
8—12 „ ...	17 „ ...	63 „
13—17 „ ...	23 „ ...	68 „
18—22 „ ...	25 „ ...	71 „
23—27 „ ...	27 „ ...	77 „
29 „ ...	34 „ ...	87 „
30 „ ...	35 „ ...	85 „
31 „ ...	32 „ ...	75 „
32 „ ...	34 „ ...	92 „
33 „ ...	37 „ ...	95 „
Nilambur Plantation.—Gneiss and laterite.		
7 years ...	13 inches ...	30 feet.
16 „ ...	14 „ ...	50 „
20 „ ...	21 „ ...	50 „
24—26 „ ...	22 „ ...	52 „
30 „ ...	24 „ ...	50 „

These figures are taken from that portion of Colonel Beddome's report (paragraphs 11— 44) which contains his notes on each year's plantation, and the data recorded are stated to be average figures.

8. In another part of his report (paragraph 81), however, he gives data which would seem to show that the average size of the trees in the older plantations (all on alluvial soil) is considerably greater. He there states the dimensions of the largest, smallest and medium-sized trees, four plantations, the results being as follows :—

Age.	Mean girth (probably breast high.)			Length of bole.		
	Largest.	Medium.	Smallest.	Largest.	Medium.	Smallest.
	Inches.	Inches.	Inches.	Feet.	Feet.	Feet.
30 years ...	67	47	29	79	65	50
31 „ ...	69	49	30	80	65	50
32 „ ...	63	46	30	83	67	50
33 „ ...	68	56	43	86	68	50

The first three lines show the average of 6 trees in each case, and the last line the average of 8 trees each. It is distinctly stated that the length is that of the bole, and not of the entire tree.

The plantations made on gneiss and laterite show a much slower rate of growth than those on alluvial soil ; the difference being considerable in height, and much less in girth.

9. Up to 10 years of age, the growth in length of teak on alluvial soil at Nilambur is at the rate of about 6 feet a year, and later on it is at the rate of only about 1 foot a year. On page 358 of the Forest Flora of North-West and Central India it is stated " that it is probable that, as a rule, Teak attains half its length with a girth of 2—3 feet." This assumption is borne out by the present figures. The trees grown upon alluvial soil in girth between 25 and 34 inches are from 77 to 87 feet high ; and from all that is known regarding the growth of Teak in similar localities, it is probable that unless damaged by storms, disease, insects, or other causes, they will attain a height of 150 feet in soil of this description, and in the climate of Nilambur.

10. From Burma we have the following data. The figures from Pegu represent averages of plantations in the Rangoon, Toungoo and Tharawaddee districts, brought together on page 358 of the Forest Flora of North-West and Central India :—

	Age, in years.	Mean girth, breast high, in inches.	Total height of tree, in feet.
Pegu	4	5—9	15—27
	10	15	40—45
	15	23	...
Thinganneenoung... ...	21	27	50—60
Garden—Moulmein	22	40	...

The fourth line is the average of 150 trees in the Thinganneenoung Plantation in the Attaran district of Tenasserim, given in paragraph 146 of the report for 1876-77 of the Tenasserim forests. Major Seaton gives the average height at 30—40 feet, but this probably means the height to the first

branch. The maximum girth was 55½ inches. The average rate of growth of the present plantations in Burma is somewhat less rapid than that of the alluvial portion of Nilambur. The last line gives the average of 15 trees measured in 1856 in a private garden at Moulmein. An instance of extremely rapid growth was the tree already mentioned, a section of which was sent from Port Blair for the Paris Exhibition, probably 6 years' old (said to have been planted in 1873, but 6 rings were counted), with a girth of 36 inches and a height of 44 feet.

11. For the Lakvalli Plantation in Mysore, the following data are given in Captain Van Someren's report for 1875-76. Age 13—15 years, mean girth 14 inches, height 32 feet. This is a remarkably slow rate of growth, considering that the soil is good, and the climate moist, though of course not so forcing as the climate of Nilambur.

12. The plantations in the Central Provinces and Berar have given the following:—

Plantation.	Age, in years.	Mean girth, breast high, in inches.	Total height of tree, in feet.
Machna, Central Provinces ...	6	7	15—22
Pili, Berar	6	4	10
Sakata, Central Provinces ...	7	11	20—25
Pili, Berar	8	8	20
Sonawani, Central Provinces ...	9	12	30—40
Machna, Central Provinces ...	8—10	9	17—30

Compared with Malabar and Burma, the rate of growth is slow, as may be expected in a dry climate and near the northern limit of the tree.

13. Outside the range of the natural growth of Teak, the following data, regarding its rate of growth, are available:—

Plantation.	Age, in years.	Mean girth, breast high, in inches.	Total height of tree, in feet.
Bamunpokri (Sikkim) ...	5	5·5	12—15
Kulsi (Assam)	5	11	29
Makum " ...	4	9	18
" "	5	11	27
" "	7	16	31

The growth at that early age is fairly good; but it does not follow from these figures that Teak in Assam and Sikkim will attain a great age, and produce good timber.

14. The following instances of older trees of known age in Assam and Bengal are on record :—

Locality.	Number of trees measured.	Age, in years.	Mean girth, in inches.
Gauhati, banks of the Brahmaputra	15	37	85
Royal Botanical Gardens, Calcutta	19	6	16
Ditto ditto ...	8	70	79
Garden at Mohesh, Serampore...	27	50	52

The trees at Gauhati were on an average 30—50 feet high.

The trees in the Botanical Garden, Calcutta, were measured in January 1856. The older trees have since been blown down by the cyclones of 1864 and 1867.

On the banks of the Hooghly at Mohesh, below Serampore, stands a grove of Teak trees planted in 1828. Their mean girth, breast high, taken by measuring 27 average-sized trees, was 52 inches. The trees were measured in January 1878, and were therefore 50 years old. They are from 40—50 feet high.

15. In paragraphs 177 and 183 of Dr. Schlich's report for 1872-73, the dimensions of a large number of Teak trees at different stations of Lower Bengal are given; but unfortunately no trustworthy information regarding their age is available.

16. *Cubic contents of trees at different ages.*—In paragraph 4 of Colonel Beddome's report a statement is given exhibiting the dimensions of the trees, sections of which were sent to the Paris Exhibition. As already stated, these trees were selected as samples of the dominant trees, *viz.*, of those which will eventually be selected to remain on the ground as the ultimate crop; but, with few exceptions, they were not selected from among the largest individuals which had much outrun their neighbours. Arranging them in groups from 10 to 10 years, the following results are obtained :—

Age.	Height of tree, in feet.	Girth at base, in inches.	Length of bole, in feet.	Mean cubic contents, in cubic feet.
4—13 years ...	48—75	21—60	32—56	10·6
14—23 „ ...	65—110	51—69	40—70	23·8
24—33 „ ...	70—110	60—105	41—72	51·3

This gives us the cubic contents at different ages as follows :—

Mean age.	Cubic contents, in cubic feet.	Periodical annual increment, in cubic feet.
9	10·6	1·1 to 9 years.
19	23.8	1·3 from 9 to 19 years.
29	51·3	2·8 from 19 to 29 years.

The annual increment increases steadily to the age of 30 years, and probably continues increasing for a considerable time beyond it.

17. *Number of trees and cubic contents of growing stock per acre.*—Regarding the number of trees and the growing stock per acre at different ages, we depend almost entirely upon Nilambur for our data. Sample areas of half an acre each were selected in each of seven plantations; each tree was measured, the cubic contents determined, and the following is the result. It is not expressly stated, but it is probable that these sample areas were all selected on alluvial soil :—*

*The length of stem to the top of sale measurement, where the head begins, of every tree in the plantations of 1844 to 1848, both inclusive, was measured by sending up a climber with a tape. In the plantations of 1858 and 1868 a large number of felled saplings were available, of which the average was taken.

The mean quarter girth was determined in the following manner:—Ten saplings were measured breast high, and in the middle of the stem at half its length, and this gave $\frac{5}{6}$ as the reducing factor. Those trees 30 inches in girth breast high were found to have a girth of 25 inches in the middle of the bole.

Name and year of plantation.	Age of plantation, in years.	Number of trees per acre.	Average length of bole, in feet.	Mean quarter girth of trees, in inches.	CUBICAL CONTENTS IN CUBIC FEET.		AVERAGE ANNUAL INCREMENT, IN CUBIC FEET.	
					Per tree.	Per acre.	Per tree.	Per acre.
Iravelly Kava...1844	33	120	59	9·7	41	4,879	1·2	148
Elanjerry ...1845	32	158	61	7·9	30	4,742	·9	148
Elanjerry ...1846	31	156	60	7·4	27	4,204	·9	136
Moolathamanoo 1847	30	140	62	7·5	27	3,713	·9	124
Moolathamanoo 1848	29	156	60	6·8	21	3,243	·7	112
Elanjerry ...1858	19	270	45	5·0	8	2,203	·4	116
Wallashary ...1868	9	750	40	3·4	3	2,491	·4	277

18. Colonel Beddome estimates that on alluvial soil, the Teak at Nilambur will reach maturity at from 60 to 80 years; that fellings will be spread in each plantation over 50 years; and that at the time of cutting (say at 85 years of age) the mean quarter girth will be 2 feet, the length of bole will be 70 feet, and the mean cubic contents of each tree 280 cubic feet. He also estimates that, at that age, there will only be 60 trees to the acre, making the cubic contents per acre 16,800 cubic feet.

No safe speculations can be formed regarding the future of a pure Teak forest like that of Nilambur. In its natural state, Teak does not grow alone, but is associated with Bamboos and a variety of other trees; and it is impossible to foresee the risk of damage by storms, insects, disease, or other causes to which pure Teak forests may be exposed. It may be doubted whether, even on the best alluvial soil, the average mean girth of trees 85 years of age will be as much as 8 feet. On the other hand, it is not impossible that the bole will be longer than 70 feet, and it is probable that it will be advantageous to allow more than 60 trees per acre. On page 155 of the Attaran Report of 1860, a plot in the Tsintsway forests (Yoonzaleen) is described, measuring 3,833 square feet, and stocked with 8 Teak

trees with clear stems to the first branch of 50 feet, the girth between 4′ 6″ and 6′ 5″; this would give 91 trees to the acre. Full stocked forests of Oak and Beech in Europe 130—180 years old under favourable conditions contain 120—140 trees per acre, with a cubic content (including tops and branches) of about 11,000 cubic feet. A forest of Silver Fir in the Jura, 180 years old, was found to contain 94 trees per acre, with a cubic content of 16,000 feet.

19. The total area now stocked at Nilambur is 3,436 acres, of which 1,787 are stocked with a full crop on alluvial soil, the rest not being expected to yield a full crop. In his estimate of the future value of the plantations, Colonel Beddome only assumes 6,000 cubic feet as the full crop expected on alluvial soil.

In natural forests, where Teak is associated with Bamboos and other trees, the number of the first and second class Teak trees (above 4′ 6″ in girth) rarely attains 10 trees per acre over large areas. The following are instances of forests exceptionally well-stocked with Teak :—

Date of survey.	Forest.	Area.	Number per acre. Class.		Total.
			Girth above 6 feet.	Girth 4½ to 6 feet.	
1876 ...	Bimaram (Central Provinces.) ...	50 acres ...	4	4·3	8·3
1870-71 ...	Pegu (Prome District) ...	17 square miles	3·6	3·0	6 6

Sketch of the Flora of Rajputana.

By George King, M.B., F.L.S.,
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As might be expected from its geographical position and limited rainfall, the flora of Rajputana is not a rich one. The number of indigenous species is but small, and few of these are attractive in appearance. The province is divided by the Arvali range of hills into two unequal parts—the part to the eastward of the range lying in the basin of the Chambal, and that to the westward in the basin of the Indus. This division is, to a great extent, coincident with certain features in the physical configuration, meteorology and vegetation of the province; and these two portions may, therefore, be conveniently treated of separately. The vegetation of the dividing range itself, and of the outlying mountain mass of Aboo, so much more resembles that of the eastern than of the western tract, that it may be treated along with the former.

Eastern Rajputana.—The country to the east of the Arvali is (with the exception of the Jaipur State) more or less hilly, and has a climate and a flora resembling those of Central India and the North-Western Provinces. Where not actually hilly, the surface is, to a considerable extent, undulating. Cultivation is, on the whole, scanty, and is chiefly confined to the lower and flatter lands, while the higher parts remain to a large extent covered with their original vegetation, and on them may be found in abundance plants which, in the more completely cultivated provinces of North-Western India, are confined to the comparatively small tracts of waste and unreclaimed land.

As is the case in other parts of India with a similar vegetation, the majority of the trees and shrubs come into flower during the hot season, while the herbaceous plants blossom chiefly during the rains. Many of the latter are, moreover, annuals which wither and die as the cold season approaches. The cold season corresponds to the winter of temperate countries, and during the whole of it the aspect of the uncultivated parts of the country is brown and barren. The flowering of the shrubs and trees during the hot weather does little towards increasing the beauty of the scenery. On the contrary, it, if

anything, intensifies the feeling of barrenness and aridity. With the first fall of rain, myriads of seeds that had lain dormant in the parched soil spring into life, and in the course of an incredibly short time the whole of the country, even to the tops of the barest hills, is clad in a carpet of delicate green, while the pleasant sound of running water can actually be heard in the valleys. The largest tree of this part of Rajputana is the Semul (*Bombax malabaricum*), which on the Arvalis and Aboo attains a considerable size. The finely buttressed grey trunk, spreading arms and gaudy red flowers of this species make it a striking object in the landscape wherever it occurs. Ranking after the Semul in size are *Prosopis spicigera*, *Sterculia urens*, *Semecarpus Anacardium*, the two Acacias (*leucophlœa* and *Catechu*), *Anogeissus latifolia* and *pendula*, *Dichrostachys cinerea*, *Cordia Rothii*, *C. Myxa*, and *Phyllanthus Emblica*. These yield both fuel and building timber in parts of the region where neither is over-abundant. *Erythrina suberosa*, with its ungainly trunk and branches but handsome scarlet flowers, and the pretty geranium tree of the Anglo-Indian (*Bauhinia purpurea*), are not uncommon. *Gmelina arborea*, a tree which yields an excellent timber, and which occurs over almost the whole of India and Burma, is found sparingly in the Arvalis. The gum-yielding salai tree (*Boswellia thurifera*), so abundant in the territory to the eastward of the tract, is not uncommon in Meywar and the Arvalis. The dâk or pallás (*Butea frondosa*), which in various parts of Central India covers immense areas to the exclusion of pretty nearly every other tree, is far from abundant in any part of the region. Two Terminalias (*tomentosa* and *Arjuna*), both valuable as timber trees, occur sparingly on the eastern frontier of the tract, but are rare elsewhere. *Schrebera swietenioides*, a little-known and rather rare tree, has been found by Dr. Brandis in Meywar.

Climbing plants are not numerous, the most notable being two species of Cocculus (*villosus* and *Leœba*), *Cissampelos Pareira*, *Celastrus paniculatus*, two vines (*Vitis carnosa* and *Vitis latifolia*), and *Mimosa rubicaulis*.

The shrubby vegetation, which in every part of the region is so much more prominent than the arboreal, consists largely

of capers, jujubes, tamarisks, and *Grewias*. Of the capers by far the commonest is *Capparis aphylla*, a prickly leafless shrub with a handsome plum-like fruit, which flourishes over all the driest parts of North-Western India, and extends to Arabia, Nubia, and Egypt; *Capparis spinosa* (which yields the eatable caper) is much less frequent; *Capparis horrida*, a scrambling plant which often climbs on trees, is not uncommon; while a fourth species *Capparis sepiaria* (indigenous in the south of India), is here and there cultivated as a hedge plant. The small jujube (*Zizyphus nummularia*) is very abundant, and, covering, as it often does, large tracts of country, has great value as a fodder plant: it is also much used for hedges. *Zizyphus xylopyra* is a less abundant species, which sometimes, in protected spots, attains to the dignity of a small tree and yields a useful wood, while its bark is used in tanning. In every water-course tamarisks of several species abound. One of these (*Tamarix gallica*) is a cosmopolitan plant, which is found in suitable localities all over India and Ceylon, in China, Japan, and Siberia; specimens of it have been gathered in Yarkand, in Thibet, at 11,000 feet above the sea, and it is common in many parts of Northern Africa and Southern Europe. *Tamarix dioica*, an exclusively Indian species, is also abundant. Of the Grewias, *Grewia populifolia*, *Grewia pilosa*, *Grewia villosa*, and *Grewia salvifolia* are the common species. These all yield tough wood, which, however, is rarely large enough to be of much use; and the fruits of all four are more or less eatable. In addition to these, the most notable shrubs are *Helicteres Isora*, the curious spirally curled seed-vessels of which have a fanciful value as a remedy in dysentery: *Celastrus spinosus* and *Celastrus senegalensis*, *Buchanania latifolia*, *Cassia auriculata*, *Woodfordia floribunda* (the scarlet flowers of which are used as a dye), *Casearia tomentosa*, *Diospyros montana*, *Holarrhena antidysenterica* (named from its reputed value as a cure for dysentery), *Calotropis procera*, *Vitex Negundo* (esteemed as a remedy for rheumatism), and *Clerodendron phlomoides*. Two cactus-like fleshy *Euphorbias* (*Euphorbia Royleana* and *Euphorbia neriifolia*) occur in the hills, but are much less abundant than in the tract to the west of the Arvalis.

Bamboos are represented by a single species (*Dendrocalamus strictus*), which attains large dimensions only on Aboo and the higher parts of the Arvalis.

The herbaceous vegetation consists of *Leguminosæ* of the genera *Alysicarpus*, *Desmodium*, *Crotalaria*, *Cassia*, &c., of various widely distributed species of *Compositæ* and *Rubiaceæ*; *Boraginaceæ* being also rather numerous, and *Scrophulariaceæ* less so. During the rains a few *Convolvulaceæ* appear, and grasses and sedges are abundant.

Owing to its heavy rainfall, Aboo is, as regards vegetation, by far the richest spot in Rajputana. On the higher parts of the mountain, humid types appear which are unknown on the plains below. Most noteworthy of these is an epiphytal orchid (a species of *Aerides*) which clings to the mango trees, and in the rains produces fine racemes of delicate pink flowers. The occurrence of a charming white wild rose and of a stinging nettle (*Girardinia heterophylla*) also at once reminds the visitor to Aboo that he has left the arid region below, and recalls to his mind the semi-temperate vegetation of the Himalayas and Nilgiris. Magnificent trees of *Michelia Champaca* are found, especially beside the temples, and weeping willows adorn the margin of the lake near the station; but the latter two species have both doubtless been planted. A yellow jasmine (*Jasminum revolutum*) abounds on Goroo-Sikhur, the highest peak of the mountain; but this is also doubtfully indigenous. *Cratæva religiosa*, with its creamy yellow flowers and delicately-tinted stamens, is common on the middle and lower slopes of the hill; while *Carissa Carandas* is so abundant that during part of the hot season its pretty white flowers scent the air for miles round the station with their delicious fragrance. The prevailing tree on the slopes of Aboo is the mango. It is doubtfully indigenous and was probably originally introduced by the numerous pilgrims who have for ages frequented the sacred shrines for which the mountain is famous. Now, however, it is thoroughly naturalised, and is the commonest of the larger trees. *Pongamia glabra* is found in several of the lower valleys of Aboo (wherever it occurs on the plains below it has usually been planted) and *Sterculia colorata* is not uncommon. Shrubby and

herbaceous *Acanthaceæ* of several species abound. Very common also is *Mallotus philippinensis*, the powder covering the capsules of which forms at once a valuable dye-stuff and an efficient vermifuge. On the lower slopes of the mountain, and in the dense belt of jungle which surrounds its base, are found most of the species which are characteristic of the plains. Many of the latter (for example, *Salvadora persica*) ascend to the very highest peaks of the mountain, and thus intermix with the more temperate forms which are confined to the latter.

Of introduced Indian plants which are found usually in gardens or near villages over the whole of the eastern tract, the most prominent are the peepul (*Ficus religiosa*), the banyan (*Ficus bengalensis*), the gular (*Ficus glomerata*), the ungeer (*Ficus virgata*), the mulberry (*Morus alba*), the tamarind (*Tamarindus indica*), the mango (*Mangifera indica*), the ním (*Melia Azadirachta*), the bábul (*Acacia arabica*), the ber (*Zizyphus jujuba*), the siris (*Acacia Lebbek*), the jamun (*Eugenia Jambolana*), the mehndi (*Lawsonia alba*), the pomegranate (*Punica Granatum*), and the peach (*Amygdalus persica*). *Mimusops indica* and *Elengi*, *Ailanthus excelsa*, and *Flacourtia Ramontchi* are also occasionally met with. The bábul is quite naturalised in spots where the winter cold is not too intense, and where the sub-soil retains a little moisture : its timber and bark are both highly prized. Among fruit trees cultivated in gardens, two American species are very common; these are the custard apple (*Anona squamosa*), and the guava (*Psidium Guava*). *Argemone mexicana*, *Parkinsonia aculeata*, *Opuntia Dillenii*, and *Acacia Farnesiana* (also introductions from America), are frequently met with. *Nerium odorum*, a shrub closely allied to, if not identical with, the oleander of Southern Europe, is also common in gardens.

Western Rajputana.—To the westward of the Arvalis the country is much flatter and drier, and as the Sind and Punjab frontiers are approached, it passes into actual desert. It is, however, by no means destitute of hills, for numerous low ridges of a red sandstone rise here and there, and in other parts there are undulating areas of hardened sand. The rest of the

country is for the most part a plain of loose sand, which, everywhere more or less saline, becomes increasingly so towards the south-west, where the Loni loses itself in the Runn of Kutch. Except that they support a few of the fleshy *Euphorbias* already mentioned many of the hilly ridges are utterly barren. The little rain that falls on these bare rocks is at once carried off in rapid torrents which are often lost in the sand at a short distance from their bases. The few torrents which do succeed in carrying their water to any distance unite to form the Loni, the one river of this part of the country. But although water can be had by digging at certain parts of its bed at almost any season of the year, and stagnant pools may here and there be found at all times, it is only during the brief and scanty rainy season that anything like a continued current can be seen in any part of the Loni. The rainfall, which over the whole area is scanty and uncertain, gradually diminishes as the Sind and Punjab frontiers are approached. Erinpura, a station near the base of the Arvalis, has a rainfall of about 12 inches in the year; whereas Western Marwar, Jesulmir, and Bikanir have probably less than a third of that amount.

It must not be supposed that the Arvali range forms a rigid boundary separating two distinct floras; on the contrary, the majority of the plants already mentioned as characteristic of the eastern tracts are found on the west of the range. Near the base of the Arvalis, the soil is good and supports a belt of what would, for Western Rajputana, be a comparatively luxuriant vegetation, were it not ruthlessly preyed on by the inhabitants for fuel and timber for themselves and fodder for their cattle and camels. In passing westward from the Arvalis, such of the species already mentioned as are unable to withstand the increasing dryness of the climate, and the saltness of the soil, are represented in gradually diminishing numbers by stunted, half-starved specimens, and the majority of them finally disappear altogether. On the other hand, a few species of a thoroughly desert type gradually appear, and these latter increase in proportion to the former, until on the western frontier of the region they form almost the entire vegetation. These desert plants are outliers of the Arabian and North African

flora, and are common to all low-level Asiatic deserts, while some of them penetrate even to the comparatively high arid tracts of Central Asia. Next to the floral poverty of this tract, the most notable fact that strikes the observer is the tendency of plants, which in moister regions are herbaceous, here to become tough and shrubby, and of the whole vegetation to develop epidermal armature in the shape of hairs and thorns. The common weed (*Solanum Jacquinii*) which in the Gangetic plain is moderately covered with stiff bristles, here presents the appearance of a vegetable hedgehog. The spines of the bábul are about twice as long and as thick as they are in Malwa, while the small ber bushes, everywhere formidable, are here little more than mere bundles of spines.

The largest trees in Marwar are those that have been planted in gardens and near tanks or wells. Hardly one of any indigenous species is ever found exceeding ten or twelve feet in height. The commonest of these latter are *Prosopis spicigera* *Salvadora persica*, *Cordia Rothii*, *Acacia leucophlœa*, with *Acacia arabica* in the kind of spots already indicated, and *Sterculia urens* on the less barren hills. *Anogeissus pendula* and *Dichrostachys cinerea* occur but sparingly, and hardly ever exceed the dimensions of under-shrubs. Towards the Sind desert, the only tree to be found wild is said to be *Acacia rupestris*, a form almost totally absent from the eastern tract.

By far the handsomest shrub indigenous to this part of Rajputana is *Tecoma undulata*, which has the double merit of bearing large orange-coloured bell-shaped blossoms, and of bearing them simultaneously with its handsome shining leaves. This plant is so indifferent to climatic conditions that, although naturally found on some of the drier ridges of Marwar, it thrives excellently in the Botanical Garden in the steamy climate of Calcutta—a peculiarity which it shares with *Dichrostachys cinerea* and *Acacia leucophlœa*. Next to *Tecoma undulata*, the finest indigenous shrub is *Acacia Jacquemonti*, the polished stems and thorns and sweet-scented yellow flowers of which make it an object of much beauty and interest. In addition to these, the shrubby vegetation is composed of the following species already mentioned as occurring more abundantly in the eastern tract:—

Capparis aphylla and *spinosa*; *Helicteres Isora*; *Grewia populifolia, pilosa, villosa*, and *salvifolia*; the two *Zizyphi* (*nammularia* and *xylopyra*); *Cassia auriculata*; *Clerodendron phlomoides*, and *Vitex Negundo*. The tamarisks already mentioned are found abundantly in the salt-impregnated bed of the Loni, and two other species of the same family (*Tamarix articulata* and *Myricaria germanica*) also begin to be found. Both these are common in Afghanistan and in Western Asia generally; while the second of the two extends also to high altitudes both in the Himalayas and in some of the mountain ranges of Northern Europe. *Balanites Roxburghii* (a prickly scraggy shrub common in Southern India, Central Provinces, and other dry parts of India) is here pretty common. *Balsamodendron Mukul*, a shrub which yields a gum called *mukul* or *gugal*, and which extends to the dry countries far to the westward of India, begins here to be as abundant as east of the Arvalis it is rare. *Ephedra alte*, a bush common in the west of Asia and north of Africa, is said to have been found in Jesulmir. The pretty little camel-thorn (*Alhagi Maurorum*) which, occurring in the eastern tract and far beyond it in India, is also distributed in Southern Europe and Western Asia, here forms a prominent feature in the vegetation of the sandy tracts. Associated with it are a few other bushes, such as *Calotropis procera* and *Orthanthera viminea* (both of which yield an excellent fibre), and here and there *Periploca aphylla*.

Of the herbaceous vegetation, the prominent species may be indicated as follows: *Peganum Harmala* (a rutaceous plant, which is found in the Deccan and Punjab, and which is distributed to the westward along the Mediterranean coasts as far as the Atlantic) occurs in plenty in many spots, as, for example, near Palli. *Polygala abyssinica* is not unfrequent in places. The most abundant leguminous plants are *Crotalaria Burhia* (much valued for fodder) and *Tephrosia purpurea*. *Compositæ* are represented by one or two *Blumeas*, *Vernonia cinerea*, *Microrhynchus nudicaulis*, and *Berthelotia lanceolata*; here and there *Tricholepis radicans* and *Echinops echinata* are to be seen; and near irrigated spots may be met with *Machlis hemispherica*, *Sphæranthus hirtus*, and *Cyathocline lyrata*.

Not uncommon in gardens as weeds of cultivation are *Saponaria Vaccaria*, *Trianthema crystallina*, *Asphodelus fistulosus*, and *Fumaria parviflora*. Of Acanthaceous plants, the most frequent are *Lepidagathis trinervis* and *Barleria noctiflora*, with here and there two plants of wide distribution in India,—namely, *Justicia procumbens* and *Peristrophe bicalyculata*. *Boragineæ* are numerous in individuals belonging to the genera *Eritrichium* and *Arnebia*; *Trichodesmus indica* and *Tournefortia subulata* are common near Jodhpur. Several *Cleomes*, one or two *Farse tias*, two or three species of *Abutilon* and *Sida* are also common. *Tribulus terrestris*, *Corchorus depressus*, *Verbena officinalis*, *Lippia nodiflora*, *Bergia æstivosa*, *Cressa cretica*, *Convolvulus arvensis*, *Evolvulus pilosus*, *Withania somnifera*, *Solanum xanthocarpum* var. *Jacquinii*, *Salvia brachiata*, *Polygonum Roxburghii*, and *Aristolochia bracteata* are found in spots where there is a little admixture of vegetable mould, and by the margins of tanks and irrigated spots. *Amarantaceæ* are represented by *Achyranthes aspera*, *Alternanthera sessilis*, *Amaranthus lividus*, *Aerua lanata*, and *Pupalia velutina*. Such *Chenopods* as *Anabasis*, *Atriplex* and *Salsola* abound where, as towards the mouth of the Loni, the sand is highly saline. Parasitic on the roots of *Calotropis* is a pretty species of *Orobanche*. The tanks are not destitute of vegetation, for in their water may be found, though sparingly, *Vallisneria spiralis*, *Utricularia stellaris*, *Potamageton pectinatus* and *natans*, while by their margins several species of sedges, and notably *Hymenochæte grossa*, are often abundant. Several species of *Andropogon*, *Anthisteria*, *Cenchrus*, and other wiry grasses are distributed over the whole area; and towards the Sind frontier one of these, known locally as *mart*, constitutes a large proportion of the scanty vegetation. Besides this grass, the vegetation on that frontier consists almost exclusively of the small acacia tree already mentioned (*Acacia rupestris*), of a plant of the rhubarb family with curious hairy seed-vessels known locally as *phog* and botanically as *Calligonum polygonoides*, the woolly-looking plant *Aerua lanata* (locally called *bhin*), *Anabasis multiflora*, and a troublesome bur grass, *Cenchrus biflorus*.

In the sandier parts of this western tract the staff of life is derived from a rain crop of millet, which is sown as soon as a shower in July or August makes it worth while to give a hurried ploughing to the patches of soil which the inhabitants are pleased to call fields. Wheat is a garden crop confined to the small patches which it is possible to irrigate from wells. In the sands of Bikanir, water-melons occur spontaneously in such numbers as to form for some months in the year no small part of the food of the scanty population. The seeds of these and of other cucurbitaceous plants cultivated in gardens are ground, during times of scarcity, into a kind of flour.

From the preceding sketch it may readily be inferred that the country is barren and infertile, and it is difficult for one who has not visited it to realise that, in spite of its many natural drawbacks, it affords sustenance to a human population of exceptionally fine physique, and is the breeding ground of some of the finest races of cattle and horses and of the best camels in India. The bullocks of Nagore are celebrated for their size and paces; the endurance of the horses of Mallání is proverbial; while the swiftest riding-camels in India are born and bred in Bikanir. It is perfectly wonderful to see the apparently bare barren plains from which these animals contrive to pick up their daily food.

Nothing has hitherto been said of the cryptogamic vegetation of Rajputana. As might be expected, the richest spot in this respect is Aboo; but even there only about a dozen species of ferns occur, and of this small number only *Adiantum caudatum*, *Adiantum lunulatum*, *Cheilanthes farinosa*, *Nephrodium molle*, *Nephrodium cicutarium*, and *Actiniopteris radiata* can be said to be abundant. *Adiantum Capillus-Veneris* is found in a few spots, and *Botrychium virginianum* is very rare. Of mosses there are a few which, during the rains, form pretty tufts and festoons on the branches of the trees on the south-western slopes of the mountain, but at other times they are shrivelled and brown. There are a good many lichens on the trees and a few on the rocks. *Algæ* are not numerous. During the rains a good many *Fungi* spring up on decaying wood, and an edible *Agaricus* is found on grassy banks; *leaf fungi* are few in number.

In the eastern tract, the only ferns ever seen are *Adiantum lunulatum* and *caudatum*, *Nephrodium molle*, and *Actiniopteris radiata*. The latter is found only on walls, where it is associated with *Funaria hygrometrica*, the only moss at all common in the region. These species occur very sparingly, indeed, in the western tract, and only in shady crevices of rocks or on old moist walls. In wells, the maiden hair, *Adiantum Capillus-Veneris*, is occasionally met with on both sides of the Arvalis.

As has already been remarked, the province of Rajputana does not possess a flora peculiar to itself, but rather presents a field on which the adjacent floras of dry India and of the deserts of Western Asia and Northern Africa interosculate. In other words, there are, so far as the writer is aware, no species peculiar to this area, every plant in it being found also either in the adjacent provinces of Central India, Guzerat, the Punjab, North-Western Provinces, or in the dry regions of the Deccan and Southern India; while several of them occur also in countries far beyond the limits of the Indian Empire.

Extracts from the Report of the Royal Gardens at Kew for 1877. By Sir J. D. Hooker, K.C.S.I.

Boxwood.—For some years past the supply of this important wood has diminished in quantity and risen in price. It is derived from the forests of the Caucasus, Armenia and the Caspian shores. The wood of best quality comes from the Black Sea forests, and is principally shipped from the port of Poti. The produce of the Caspian forests, known in the trade as "Persian" wood until last year, was also exported through the Black Sea from Taganrog. This found its way after the commencement of the war, *viâ* the Volga Canal, to St. Petersburgh. The produce of the Caspian forests is softer and inferior in quality to that of the Black Sea. It is a matter of interest to see whether one result of the war will be to open those Black Sea forests which the Russian Government has hitherto kept rigorously closed. The falling-off of the supply has led meanwhile to various attempts to find substitutes for Boxwood for many purposes. Messrs. Joseph Gard-

ner and Son, of Liverpool, have introduced with some success Cornel (*Cornus florida*) and Persimmon (*Diospyros virginiana*) for shuttle-making, for which purpose hitherto Box has been in great demand.

Nan-mu Tree of Chinese.—Dr. Brandis has drawn our attention to a passage in Mr. Davenport's report on Yunnan [Parliamentary Papers, China, No. 2 (1877,) p. 13,] giving an account of the " Nan-mu" tree, the wood of which is so highly valued by the Chinese. If it could be accurately identified, the cultivation of the tree would no doubt be very profitable in India, and I, therefore, place on record what has been ascertained respecting it. The following is from Mr. Davenport's report:—

"This part of Yunnan (which seems to be between 25° and 26° N. lat.) produces the famous Nan-mu, so highly esteemed by the court for building purposes, and by the wealthy for coffins, on account of its durability. This timber is to be seen in perfect condition after the lapse of nearly three centuries in the shape of enormous pillars in the tombs of the emperors of the Ming dynasty, and has usually been supposed by foreigners to be Teak. The tree is tall, thin, straight growing, having no bough or twigs on the stem, but suddenly shooting out branches at the top, somewhat like a canopy over a maypole. Its bark is of a peculiar ashy grey colour, and a specimen of the leaves, gathered by myself, accompanying this report, will prove beyond all doubt that it is not a member of the Teak family.

During the Ming dynasty this wood had already become scarce (having probably been everywhere cut down and not re-planted), and was brought chiefly from almost inaccessible valleys inhabited by wild tribes. The imperial palaces at Pekin were built almost entirely of this timber.

At the present time this wood is imported into Shanghai in planks, measuring 8 feet long by 13 or 14 inches in diameter, for which the highest price is 200 dollars per plank. Whole coffins range from 100 dollars to 800 dollars.

The quality is judged of chiefly by the pungency of the scent. The leaves sent by Mr. Davenport to the Foreign Office cannot now be traced, but by the courtesy of E. Brad-

ford, Esq., late Master of the Apothecaries' Society, to which the specimens of drugs collected by Mr. Davenport were sent, I have been favoured with a further fragmentary specimen transmitted by Mr. Davenport, and also with specimens of the wood brought to this country by Wm. Lockhart, Esq., who states that "it is also used largely by Chinese gentlemen who take a pride in their libraries to make boxes for sets of volumes, and also to place between sets of volumes."

The leaves are too slender a basis for a certain botanical determination in the absence of flowers and fruits. But it appears extremely probable that the tree belongs to the family *Lauraceæ*, and the leaves themselves agree very closely with those of *Phœbe pallida*, Nees.

West Indian Forests.—Although scarcely falling within the province of this report, I cannot but record a word of warning as to the utter apparent absence of any restriction upon the destruction of the forests of the West Indian Islands, which must, as in some cases has already proved to be the cases, be injurious and even disastrous to those colonies.

With respect to Jamaica I extract, from a paper communicated to me by Mr. Thomson, the following particulars, which I think speak for themselves :—

"In certain localities hundreds of thousands of acres have been converted into desert by the wholesale destruction of the forests. In other localities hundreds of thousands of acres would, from the same cause, now be utterly unproductive, but for the interposition of foreign trees, [Logwood, Mango.]

"In consequence of the facility with which land is everywhere obtainable in Jamaica, the peasantry cut down annually 40,000 acres of forest land and thick bush on which to plant yams and other provisions. Innumerable timber trees, young and old, are thus yearly destroyed. These clearances are made in the most seasonable districts, and in many instances the excessive rainfall in such districts is perceptibly diminished in consequence of the large extent of these clearances. No conservation of the forest having ever been attempted here, the result is, as regards timber, that the resources of the island are practically nil. There is indeed some timber in the

inaccessible hills of the interior. Nearly all the timber required for building purposes is imported into the island, the annual value of which amounts to about 50,000*l.* Even the sleepers lately used for laying down the few miles of tramway in and near Kingston were imported. The unproductiveness of the island regarding timber is further to be deplored when our luxuriant tropical resources are borne in mind, and also when it is remembered that only one-thirtieth of the island is devoted to agricultural operations. In the event of any considerable advancement being made in the prosperity of the island, a very large expenditure would be entailed for the importation of timber."

The following extract from a letter received from Dr. Impray, equally seems to me to show the necessity of some forest supervision in that island:—

"*Pimenta acris*, (Black Cinnamon or Bois d' Inde), one of our most valuable timber trees, is being fast exterminated. We have no forest law, and the valuable timber trees of the island are cut down remorselessly, small and great, and of course none are re-planted. From the leaf of the *Pimenta acris* an essential oil is distilled, of which the far-famed (in America at least) Bay-rum is made. This perfume is used all over the United States. I believe there is almost a prohibitory duty on the oil, but it is smuggled into the country. Here the material will soon be exhausted, as the leaves are purchased at so much a hundred weight, and the negroes are cutting down all the young Black Cinnamon trees wherever they can get at them to secure the leaves.

Wood for Coffins in China.

It is well known that large sums are spent by the wealthy classes in China on certain rare and valuable kinds of wood for coffins. A considerable trade in woods for this purpose is being carried on, chiefly from Yunnan and other provinces of South China, northwards. Some time ago an English Missionary, travelling from Shanghai to Bhamo, met the Governor of a province on his way to Pekin, who was accompanied by strings of horses carrying planks of wood to give as presents to his

friends to make coffins. A collection of ten different kinds of woods used by the Chinese for coffins was lately sent to Kew by the Colonial Secretary for the Straits Settlements. All these woods were of the same good character, rather soft, very fragrant, and some with a fine silky grain. The prices are remarkable, ranging from a few pounds to £150. The extreme prices are almost fabulous; one case is reported of a coffin for a Mandarin, costing £600, and made entirely of wood.

One of the most valuable of these coffin woods is the Nan Mu, which grows in Yunnan, a tall tree with straight and clean stem, similar in general appearance to the wood oil trees of Burma. This tree has erroneously been identified with *Xylia dolabriformis,* the Pynkado of Burma. It probably, however, belongs to the family of Laurineæ.

The fragrant woods from Tavoy and Mergui, belonging to the genus *Cinnamomum* which were sent to the Paris Exhibition by Major Seaton, seem to be similar to some of the woods used for coffins by the Chinese, and they are again very similar to the Nepal Camphorwood, the Malligiri or Gunserai of Northern Bengal and Assam (*Cinnamomum glanduliferum*)—D. B.

On the Cinchona Plantation at Thantoungyee, B. Burma.

By the late Mr. S. Kurz.

HAVING visited last week the Cinchona plantation on Thantoungyee hill at your request, I have now the pleasure to submit to you the present memorandum.

From the few observations made with inferior instruments, the temperature appears low enough, although the place lies only about 3,800 feet above sea, to guarantee the growth of Cinchona at Thantoungyee. The atmosphere, however, will turn out to be too dry during the hot season. This is fully confirmed by the vegetation that covers these ridges. The forests there are evergreen forests, belonging to the variety, which I designated in my letter to the Conservator of Forests, British Burma, dated 29th May 1868, as UPPER DRY FORESTS. They consist chiefly of *Schima Noronhæ* and *Sch. oblata*,

Myrica Nagi, Albizzia stipulata, Helicia robusta, Quercus dealbata, Eurya japonica and one or two other species, *Garcinia anomala,* an arboreous *Saurauja, Pyrenaria camelliæflora* in abundance, *Ternstroemia japonica, Anneslea monticola, Calophyllum spectabile, Pithecolobium sp.* (near *P. angulatum*) and another leguminous tree only found in leaf but very similar in habit to *Albizzia lucida, Dillenia aurea,* a probably new species of *Castanopsis* in great abundance, *Bischoffia javanica,* a large-sized bamboo called 'Kyellowa,' *Beilschmiedia, Turpinia nepalensis,* two arboreous species of *Araliaceæ, Podocarpus neriifolia* and a few other trees in less abundance. Along the choung appear a splendid *Livistona* and *Pandanus furcatus,* the latter in large number. Of creepers and climbers are especially seen—*Mucuna macrocarpa, Rubus rugosus,* a climbing berry-bearing bamboo, here called 'Wathabwot,' but different from the one so named in the Pegu Yomah, three or four species of *Vitis,* amongst them an *Ampelopsis,* a fine *Calamus* possibly new, with the leaves white underneath, *Smilax lancifolia,* a *Bauhinia, Cnestis ignea, Lygodium polystachyum, Stenochlæna scandens,* etc. The undergrowth is chiefly composed of *Areca triandra, Melastoma malabathricum, Wallichia caryotoides, Maesa ramentacea,* a species of *Camellia, Tabernaemontana, Psychotria, Leea Staphylea* (?), a *Wendlandia,* etc. The herbage covering the dry ground is composed of *Strobilanthes Brandisii,* and locally of *St. pentstemonoides, Peliosanthes macrophylla, Tupistra nutans, Ophiopogon, Carex, Commelyna obliqua, Polygonum chinense,* a large *Phrynium, Alpinia nutans* and some other plants now without flowers or fruits, a species of *Pollinia* locally forming pasture grounds, *Dianella,* a large *Osbeckia, Molineria recurvata,* a fine large *Begonia, Lepidagathis,* and a number of ferns such as *Pteris aquilina, Aspidium, Nephrodium* and *Gymnogramme decurrens.* The stems of trees are but sparingly covered by mosses, but rich in cortical lichens, and, at my visit, were a good deal dried up, even as the *Hymenophylla, Xyris Wallichii, Asplenium laserpitiifolium, Niphobolus* and *Pleopeltis,* which are found frequently along with them. On granitic rocks, *Xyris Wallichii, Sonerila seccunda* and *Didymocarpus mollis* are frequently seen. The ground is, during the hot season, densely

covered by dry leaves, &c., and jungle-fires enter these forests with as much facility as they enter the leaf-shedding forests of the lower regions. In fact, a large jungle-fire that broke out during my stay at the plantation, has shown me fully the destruction to which these forests are subjected during the hot season. The devastation by fire here is quite equal to that experienced in the plains, and where the large bamboo prevails even more fearful.

The soil is a light red soil, no doubt the result of decomposition of felspar of granitic rocks, with a great preponderance of rather coarse quartz-sand. The surface-soil is only to a very small depth, nowhere exceeding a foot, discoloured either by the decomposition of vegetable parts, or by the ashes of burnt-down vegetation. Huge rounded granitic rocks are seen here as everywhere in the Karen hills, striking out from the ground, or lying loosely on or along the ridges, or carried down to the choungs.

I should think that the locality was an excellent one for the cultivation of tea, and I am still more supported in my belief by the fact that nearly three-fifths of the forest trees forming these jungles are of the same family to which the tea-plant belongs, *viz., Ternstrœmiaceæ.* Besides, a species of *Camellia,* most probably identical with the Assam tea-plant, is found here plentifully along the Paloun, a choung which flows through the Cinchona plantation. But not a single kind of *Rubiaceous tree* was observed by me during my few hours' ramble through the surrounding forests.

The Cinchona will, no doubt, thrive here; but the question is, whether the cultivation at this place will really turn out remunerative. The trees will attain the same height and growth as the trees now composing these forests, that is, they will remain stunted and branched. Meanwhile, should they be planted along a choung in a deep alluvium, resting on primary rocks, it would cause the plants to grow up to be large-sized trees. It is for the latter reason that I should give preference to a formerly selected locality at Plumadoe, although I admit that the absolute elevation of Plumadoe valley is not sufficiently high (only about 2,200 feet). In my opinion, Cinchona would

thrive best in those forests, which I have mentioned in my letter to the Conservator of Forests above alluded to, as Upper Moist Forests, occupying the valleys and north and north-east faces of ridges, at elevations from 3 to 6,000 feet. The absolute height and depression of temperature caused by it are of little value, if not accompanied by a corresponding degree of dampness of the atmosphere. Nor is it absolutely necessary to go so high up the hills to obtain a temperature suitable for the cultivation of Cinchona. In fact, it is well known, and all my observations in Burma and elsewhere in India have taught me that valleys are much cooler and moister than ridges and summits of hills; so much so that, for instance, the temperature of Bogelay village at 3,000 feet elevation is more than 3 degrees higher than that of Palawa Zeik in Toukyeghat, hardly 500 feet above the sea. Unfortunately, there are no complete thermometrical observations at my disposal, either of Thantoungyee or of Plumadoe valley which could enable me to compare these two localities from a climatological point of view.

Dated Camp Otdweng, Toungoo, the 26th April 1871.

The function of the Pines and the Larch in the Production of soil.

(*Continued from page* 187.)

Of the three species of Pine which, in Europe, are found in cold climates—one, the *Pinus sylvestris*, is widely distributed; the other two, *P. montana* and *P. Cembro*, are very rare. The Larch is associated with these Pines either towards the pole or on lofty mountains.

The most important of the European Pines is, undoubtedly, the *P. sylvestris*, or 'Northern Pine,' known also by other names taken from the different localities in which it occurs, such as 'Auvergne, Briançon, Haguenau, Riga, Scotch or Norway Pine.' It is easily recognized from some distance by its ashy green-grey foliage, the colour of which is caused by the short light-coloured needles. The cones and the bark of the base of the stem have also a grey tint, but the higher portion of the bole,

and the point from whence the branches proceed, are distinguished by the characteristic bright red colour of the bark. This Pine is remarkable for the widespread area of its distribution. Found both in the plains and in the mountains, it advances from the extreme north of Europe to the southern regions, from the Icy Sea to the Mediterranean. On the Baltic Coast it forms, so to speak, one immense forest of 50 millions of hectares. As much again is found on the plateau of Central Russia, and the range of the tree extends thence beyond the Ural Mountains into Upper Siberia, so that it may be called the tree of the Northern deserts. In the valley of the Danube it is only met with in the mountains; in the Alps it is sometimes found at great elevations on southern exposures, owing to the protection afforded by the great mountain chain; in the Pyrenees it still forms forests at 1,500 metres, rising gradually thence to 1,800 metres, and extending itself westwards into the Basque region. Thus, passing from the north to the south of Europe, the elevation of the station of this Pine rises gradually, and seems in each region to be comprised between extreme altitudes of about 600 metres apart. Taken as a whole, the area of the home of the *Pinus sylvestris* presents the figure of a vast ellipse, having its centre in Russia, its greater axis passing between Moscow and Berlin, and its lesser axis extending from Lapland to the Black Sea. It is, however, restricted to poor soil, and especially to silicious sand.

In such a soil, the conditions of vegetation are difficult, and few forest trees can easily accommodate themselves. Unmixed with other species, the vast northern Pine forest, the 'bŏr' of the Russian plains, has a peculiar and wonderful appearance; the forest mass thin and with scattered trees is open on all sides to the light; and the soil, arid or peaty, only covered with dead pine needles, or with a carpet of bilberry and heather bushes and long thin erect-stalked grasses. Further south the Pines are mixed with Oak and Birch, the white bark of the latter forming a vivid contrast with the red boles of the Pines, and the brown oak trunks. In these forests animal life is scanty and silent, the presence of roedeer or the woodpecker here and there met with only serves to render the profound solitude more striking.

In mountain localities the Pine is often found in company with the Birch and the Silver Fir; these trees, by the thick cover they give, preserve the freshness of the soil, while the Pine, with its light foliage, overcovers them and thus forms trees of splendid form and magnificent bole.

The Scotch Fir requires abundant light for its growth. In the northern regions, where the summer nights are very short, it has full light almost without break during the season of vegetation; in the almost rainless plains of the Volga the dry pure air permits a strong light to reach the ground; and in the mountains of France it is found on southerly and westerly slopes, facing the Beech, the Silver Fir and the Larch, which usually cover those towards the north and east. Of all our forest trees, it is the one which best resists wind, provided it is not constant and cold, provided it is not damp.

In form the Scotch Fir varies exceedingly; it nevertheless is always *a tree* and never degenerates into a bush as do the Beech, Spruce, Birch and Mountain Pine. Even in Lapland, on the Tana, the most northern river of Europe, beyond the 70th parallel of latitude, it still forms trees capable in size of furnishing building timber, but still varies much in shape from the short, knotty, much branched and gnarled tree to the lofty mast-like straight growing Pine, whose summit ends in a narrow cone with only thin short branches.

Trees of this type, however, are always exceptional, even in suitable localities, and fine specimens over three centuries in age and capable of giving first-class mast timber are no longer seen. The type of tree, too, seems destined to disappear from the forest of Europe, where it formed such a magnificent spectacle of vegetable growth, but a few fine young trees of it are still to be seen in certain localities, such as in Italy and at Pustelnik in Galicia.

The best forests of *P. sylvestris* which France possessed were lost with Alsace-Lorraine. In the central plateau only a few still remain, such as are seen in the gorges of the Allier, although the mountains of Auvergne might easily be covered with them. A few fine trees may still be found in the Alps, but they are getting rarer and rarer every day in the forests of Provence,

Dauphiné and Savoy. In the Pyrenees the Scotch Fir is rarely found except as isolated trees; however, in the valley of Capsir, at an elevation of 1,540 metres, on the banks of the Aude where there is merely a small brook, surrounded by lofty mountain crests which shelter it on all sides, is an almost pure forest of Scotch Fir called the forest of Mattemal. In that station, on a platform of diluvium forming a terrace on the banks of the Aude, may be found trees of two hundred years of age, with a diameter of 0·65 centimetres, and stems capable of giving 17 metres of building timber. On this little plain, cut off from the plains of France by the still inaccessible gorges of the Aude, the trees have but very slight value, but great utility; the wood cannot be extracted, and without trees the country would be uninhabitable.

The *Pinus montana* is first found with the Scotch Fir in the forest of Mattemal in the Pyrenees, and it is also in that region found on the granitic slopes of Capsir, Roussillon and Cerdagne round Mont Louis. In the Alps, as in the Pyrenees, its home is at an elevation of 2,000 metres, but its elevation varies from 400 to 500 metres lower to the same amount of higher altitude, provided it is in favourable localities. It is not possible to mistake this Pine, whose bark is uniformly grey, from the Scotch Fir which has invariably some shade of red on the stem, or at any rate at the point whence the branches begin to spring, and merely from appearance there is no difficulty in distinguishing them, for the Mountain Pine is a tree of an aspect quite different from that of the Scotch Fir, being erect, pyramidal, with numerous close short branches, growing slowly, and rarely reaching any considerable size. In the Alps it is called *suffin*, and a tree of 40 to 50 centimetres in diameter is considered a fine specimen, though sometimes, as in the communal forest of Lian in Cerdagne, a larger size, and sometimes even double, is met with. Either above or below its proper locality this Pine degenerates and becomes deformed. On the uncongenial soil of torrential deposits on which the Mountain Pine is sometimes found at the bottom of valleys, it degenerates into a bush or rather a mass of thin closely-formed stems, and this is the form which has been called *Pinus Mugho*. At the upper limit of forest vegetation,

and especially on the northern slopes of the Swiss Alps, it is found growing prostrate or trailing over the ground, which in this way it shelters well enough, and from which circumstance it is called *zwergkiefer* or *legföhre,* the 'branching' or 'prostrate' Pine. Botanists have also called it 'Pin à Crochets' in consequence of a curious sport of the scales of the cone which are often curved back in the form of a hook. The cone of this Pine is also distinguished by its shining surface from that of the Scotch Fir which is grey and not polished.

The foliage of the Mountain Pine is also of a much darker green than that of the Scotch Fir, and this difference of tint permits us readily to distinguish from a considerable distance, often of several kilometres, the horizontal line which separates the two species in the same hill side where the Scotch Fir covers the lower, and the Mountain Pine the higher slopes, the latter usually higher than 1,700 metres. Besides the localities in France the Mountain Pine occurs also in some places in the Carpathian and Sudetian Hills, and in the Caucasus. As regards soil, it has no special predilection, as it may be found equally in limestone or sand, in dry soils or in marshy bogs, sometimes it appears, being then more or less of a botanical curiosity, accompanied by a few miserable stunted Birches, in the great masses of high regions, such as the Jura, the Vosges and the Black Forest, at a considerable distance from the original localities where its growth is abundant.

(To be continued.)

Wattle-Tree Cultivation.

A CORRESPONDENT, who a short time ago sent us his views on Tasmania as a place of settlement for Anglo-Indians, writes :—

"When on a visit to Kodi-Kanel, a few months ago, I was much struck at seeing how deeply-rooted the 'Wattle Tree' had become. The curse of this tree is well known, particularly in Tasmania, where one can see hundreds of acres of valuable cultivable land crowded with wattle, which nothing will kill, except dragging them up by the roots when they are young, care being taken that the root is not broken. The process of

grubbing up the young wattles is an expensive and tedious one. The earth round the roots must first be loosened by the use of a pick, then a horse or pair of bullocks are chained on to the butt-end of the tree, and drawn in the direction the root is growing. In this manner, roots 15 to 20 feet long, carrying on an average, a young tree to every foot of root, are dragged out without being broken.

"It may not be known by many, who are now doing their best to destroy the wattle, that the bark of that tree is most valuable for tanning purposes. When the discovery was first made some eight years ago in Tasmania, quite a rush was made in all parts of the country by speculators from Hobart Town and Launceston, who bought up all the wattle shrubs from the squatters, who were glad to sell the bark at five shillings an acre; and in the course of three years, the speculators were glad to buy the bark at £2 an acre. The process of stripping the trees simply requires a ring to be cut into the wood at the butt-end of the tree, when the bark is pulled off in strips by a number of boys, who are able to climb up the tree, so as not to break the strip, and also to strip the tops of the trees, where the best bark is to be found. The strips are tied in bundles by women, and stocked in certain small depôts by men, where the bark is left for some time to dry in the sun. It is then carted away in large six-horse waggons to either of the two towns, where it is crushed at the steam mills; and eventually a large quantity is shipped to England and the other colonies. At present the bark is worth as much as £5 a ton—so that it is not only a source of revenue to the farmer as long as he has trees to strip, but in another respect; the bark having become valuable, has been the cause of his being able to get his land cleared for little or nothing; because, as the stripped trees generally die, the contractors are made to cut them down; they are then heaped in large stocks, and when thoroughly dry are burnt; whereas, perhaps, for years, the farmer has seen his land gradually becoming a wattle scrub, the growth of which he was unable to cope with. In Victoria, in consequence of the cheap and abundant supply of wattle-bark, now acknowledged to be by far the most powerful tanning bark in the world, the export

in leather trade has within the last seven years largely increased. The exportation of hides has nearly ceased, while the number imported during the seven years were 392,228. The total value of leather exported during the seven years was £1,532,703, exclusive of the amount required for consumption in the colony. In 1870, the amount of bark exported was only 1,384 tons, representing £6,418, while in 1876 the exportations amounted to 9·724 tons, the aggregate value being £60,386. As the wattle tree grows very quickly, and seems to flourish so remarkably well at Ootacamund and Kodi-Kanel, it would be worth Government's while to try an experiment at plantation, on the formation of which the following few suggestions may be useful :—

"There are three species of wattle, namely *A. pycnantha*, commonly known as 'broad-leaf,' 'golden,' and 'green;' *A. decurrens*, or black wattle; and *A. dealbata*, or silver wattle. The bark of the first is superior to any other, but the tree is of slow growth, and does not attain such large dimensions as the black and silver species. For tanning purposes the silver wattle is generally discarded. The black wattle is of vigorous and robust habit, and for commercial purposes is equal to the broad-leaf species. September, October, November, and December ought to be the stripping season. In all cases 'stripping should be thorough, as the higher branches often carry the best bark, and under no circumstances should any bark be left on the tree.' The wattle requires little attention in cultivation. Its wood can be readily utilised for cask staves, axle spokes, axe and pick handles, and many other articles requiring a tough, durable grain, and when dried it is an excellent firewood. A good profit also may be derived from the sale of the gum which exudes from the trees which yield a percentage of tannin, but they can never replace the wattle. The bark from trees growing on a limestone formation is greatly inferior in tannin. One of the largest black wattles met with gave a mean diameter of 24in., its age being 18 years. The wattle is at its prime at 10 years. After that the tree loses its vigorous, healthy habit, and is usually attacked by disease or insects.

"Wattles grow on almost any soil, but their growth is most rapid on loose sandy patches, or where the surface has been broken for agricultural or other purposes. Where the soil is hard or firm, it is recommended that plough furrows should be made at regular distances of say 5ft. to 6ft. apart, into which the seeds are to be dropped. The outer covering of wattle seed is peculiarly tough, hard and horny in character, thereby forming a protection which renders the seed comparatively impervious to ordinary germinating influences. It will, therefore, be found necessary to employ a more direct agency than simply covering the seeds with earth. Water, of a little less than boiling temperature, should be poured on the seeds, and they may then be allowed to soak in the water until soft. As the seeds are small, and ought to be sown near the surface, a very light sprinkling of earth will suffice. It would be sufficient for all practical purposes of cultivation to drop the seeds at average distances of 1 foot apart along the furrows, in which case about 7,200 seeds would suffice for an acre of land. The wattle seed is, however, inexpensive, being obtainable in most districts for the mere trouble of collecting, or it can be purchased for 8*s.* or 10*s.* per lb. There are about 40,000 seeds of the *Acacia decurrens*, or black wattle, to the lb., while the seeds of the *Acacia pycnantha*, or golden wattle, are one-fourth heavier, and consequently represent not more than 30,000 to the lb. The seeds can, therefore, be dropped along the furrows at much shorter distances, and the seedlings thinned out at discretion, whereby the chances of a regular plantation would be increased. On loose, sandy soil, on which *Acacia pycnantha* can best be raised, it might not be even necessary to break up the soil in any way; but it should be borne in mind that any opening up of the surface would materially accelerate the germination of the seed and subsequent growth of the seedlings. On such open sandy soil the straight furrow line may be dispensed with and the seeds scattered broadcast. When the young trees have attained the height of three or four feet, the lower branches should be pruned off, and every effort afterwards made to keep the stems straight and clear, in order to facilitate stripping, and induce

an increase in the yield of bark. In all instances where attention is paid to the cultivation of wattles as a source of income, care should be taken to replace every tree stripped by successional sowings, in order that there should be as little variation in the yield as possible."—*From the 'Madras Mail,' October* 18, 1878.

The Forests of Cyprus.

From "Gardeners' Chronicle" of July 27th, 1878.)

As already stated, some writers who profess to write for the public information have imagined forests of Pine, Beech, &c. Unfortunately forests of any kind of tree are exceedingly limited in area, and chiefly confined to the inaccessible parts of the mountain chains; and as for the Beech, there is no record, we believe, of its ever having been found in the island.

Formerly, it is true, Cyprus was covered with forests, and was noted for its excellent timber; but according to Unger and Kotschy there is no doubt that then, as now, the forests consisted principally of Pine trees. From the sea-level up to 4,000 feet *Pinus maritima* prevails, and above that altitude it is replaced by *P. Laricio var. Poiretiana.* Even now it is possible to trace the earlier distribution of these two Pines, and see that the Pine forests were only interrupted here and there by other trees. Although the work of devastation has been carried on very recklessly, there still exist some beautiful though thin forests of *P. maritima. Europhaca boetica* flourishes only in the shade of this Pine, and *Quercus alnifolia, Arbutus, Andrachne,* and *Acer creticum* are often associated with it as underwood, sometimes straying beyond and forming independent copses. The forests of *P. Laricio* are nobler and undisturbed, because they are in less accessible situations. This Pine clothes the heights of Troodos, Adelphos, and Machera, and these alone. Few flowering plants flourish underneath the Pines. One of the most conspicuous is the beautiful *Pæonia corallina,* and *Limodorum abortivum* pushes forth from the decaying bed of Pine foliage. *Juniperus fœtidissima* is associated with the Pine on and near the summit of Troodos, to which also *Berberis cretica* penetrates. Only the

two species of Pine named occur in the island. *Cupressus horizontalis* and *Juniperus phœnicea* are rapidly disappearing as forest trees, though the latter spreads as a shrub where the maritime Pine makes room for it. *Quercus inermis* and *Q. Pfæffingeri var. cypria*, the only arborescent species of Oak, are now quite rare as trees, and can never have had any considerable distribution in the island. *Platanus orientalis* and *Alnus orientalis* exist only by the side of the beds of streams; and *Cratægus Aronia* and *Pistacia palæstina* are rapidly disappearing, fine specimens being quite rare. The general character of the flora is quite Mediterranean, as distinguished from Syrian. One of the most noteworthy features in this is the prevalence of needle-leaved trees in Cyprus, whereas in Syria these are re-placed by flat-leaved trees. A considerable proportion (4·2 per cent.) of the species are peculiar to the island, at least they have hitherto not been found elsewhere. Of these, eleven are *monocots* and thirty-one *dicots*—two *apetalæ*, sixteen *gamopetalæ*, and thirteen *polypetalæ*. Amongst the most noteworthy are *Quercus alnifolia*, which represents *Q. Ilex*; *Q. cypria*, *Ballota*, *integrifolia*, a spiny species; *Pterocephalus cyprius*, *Salvia cypria*, *Galium suberosum*, *Ornithogalum pedicellare*, *Silene lævigata*, *Gladiolus triphyllus*, *Colchicum Troodi*, *Crocus cyprius*, *C. veneris*, *&c.* The bulb flora, it may be repeated, is still very imperfectly known.

Bamboo as a Paper-making Material.

TO THE EDITOR OF THE "INDIAN FORESTER."

DEAR SIR,—I have only just received your Journal for April, and perceive you have kindly inserted therein my letter on Mr. Smythies' experiments on Bamboo in the Central Provinces. From fortuitous circumstances, due mainly to Bamboo being a tropical product and failing supply, I regret to say I have been unable to progress much further in experimenting on its manufacture into "Paper Stock," the long-continued commercial depression being deterrent on any new enterprise in India. I am, however, daily looking for an arrival

of some thousands of stems collected for me by Government in Burma to be crushed at Rangoon by the rolls I sent out, and also some few tons from Jamaica collected for me by Mr. Robert Thomson, the author of the letters I inserted in the Society of Arts' Journals of January and March last.* I mail you herewith, and you will confer a favor if, to keep this important subject alive and promote discussion and attention, you will insert their letters in your next issue.

Mr. Thomson is again in England, and his further investigations more strongly confirm the conclusions therein referred to: placing the cheap and continuous supply of this valuable paper-making material beyond dispute, and as I venture also to add that my experiments so far have proved its value as regards quality for the purpose, I hope ere long to find the subject will acquire the importance in our great Indian Dependency which I think it merits. In the persent somewhat hazy condition of European politics, not merely speaking selfishly, but in the interests of our English Paper Trade, I think it will be admitted it would be better we should draw our supplies of raw material from India than be dependent as now almost entirely on Esparto grass, the quality of which I may add is getting less and less reliable.

That judiciously and economically carried out the manufacture of paper stock from Bamboo will pay, and pay well, I confidently assert.

I will not fail to send you samples of the paper and paper stock from the Bamboos now in transit to our works so soon as they arrive, and remain meanwhile,

Dear Sir,
Faithfully yours,
THOS. ROUTLEDGE.

CLAXHEUGH SUNDERLAND,
17th October 1878.

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* The first addressed to Sir Joseph Hooker, the second to Mr. Routledge.

CINCHONA PLANTATIONS, JAMAICA;
6th November 1877.

DEAR SIR JOSEPH,—I have thought of writing you for some time on the subject of your remarks, in your last annual report on Kew-gardens, on bamboo as a material for paper-making. I hope you will excuse the liberty I now take in submitting the views I entertain on this subject. I have taken much interest in this matter, and have been in communication for some time with the largest firm of paper exporters in America, with the object of establishing the export of the raw material from here on a large scale. I have also from time to time, in my reports to the Government, referred to bamboo* as being one of the most important paper-making materials. And I may further mention that both the *European Mail* and the *Planter's Gazette* have recently noted the encouraging prospects that exist in Jamaica of establishing a large export trade in bamboo.

Cutting the bamboo stems *en masse*, as you have stated, would undoubtedly destroy the plants; but, with great deference, I would remark that this destruction of the plants can be effectually prevented by the adoption of a different process of cropping. Thus, instead of cutting all the stems simultaneously, a given proportion of matured stems should be retained, and this need only be a small proportion, sufficient to maintain the vigorous action of the roots. The stems thus retained for the preservation of the fructions of the roots may even be moderate in size. Indeed, they may be lopped so as to superinduce the sprouting of branches and foliage near the ground. Another point to be observed consist in the manner in which the young, succulent stems are cut. They should be cut—that is, the crop for making paper—not close to the ground, but a few nodes above the ground should be left. This plan ensures the sprouting of branches and foliage from some thus left, and maintains the unimpaired action of the roots.

The continuity of supply of the bamboo by the adoption of this plan aggregated to a very considerable quantity each year; and, as has been seen, a bamboo plantation may be kept up indefinitely in regard to time.

I have seen three tons of full-grown stems obtained from a bamboo clump, covering only a few square yards. This would be an enormous quantity per acre. By the system of cropping which I propose, each succulent stem, in that condition in which a penknife is easily passed through it, when dried averages only about three pounds in weight. As many thousands of these are obtainable per acre annually, I feel sure that some ten tons of paper stock could be procured from each acre annually; putting it even at the half of this, the cultivation would prove highly remunerative.

The system of reserving a due proportion of growing stems, by which systematic thinnings would be constantly obtainable, is so obviously advantageous, that I think it would entirely supersede the plan proposed by you, namely, growing bamboo like the sugar cane, and to replant after cutting the crop. Bamboo cuttings, though they root immediately, require to be planted a long time, certainly over two years, before they produce large and vigorous stems suitable for paper making.

It is a pity that some method could not be devised for utilising the ripe bamboo stems in paper manufacture. Some years ago hundreds of tons of the ripe stems were exported from here to America, which stems, I have been informed on reliable authority, were made into paper; this trade was brought to a close owing to some difficulties in the monetary affairs of the merchant in New York to whom the bamboo was consigned. An almost incredible quantity of ripe bamboo is procurable from each acre of land, and I find that the ripe bamboo is used in China for paper manufacture. In a most interesting "Catalogue of the Chinese Imperial Maritime Customs," collection of products at the Philadelphia Exhibition, published by the authority of the Inspector-General of Chinese Maritime Customs, the following account is given of the process of treating the bamboo stems:—"The method of preparation from bamboo is as follows: The bamboo is stript of its leaves and split into lengths of three or four feet, which are packed in bundles and placed in large water tanks; each layer of bamboo is then covered with a layer of lime, water is poured on till the topmost layer is covered. After remaining in this

condition three or four months, the bamboo becomes quite rotten, when it is pounded into pulp in a mortar, cleansed and mixed with clean water. This liquid is poured in quantities sufficient for the size and thickness of the sheets required, upon square sieve-like moulds. These sheets (of which a skilful workman can make six in a minute) are allowed to dry, then taken from the mould and placed against a moderately-heated wall, and, finally, exposed to the sun to dry. The best quality is made from the shoots of the bamboo, with alum added to the infusion; the second from the bamboo itself, though a higher grade of this quality is attained by the previous removal of the green portion."

I would add that the prices of paper made from the bamboo in China range from 3 dols. 61 cents. to 21 dols. per *pecul* (133⅓ lbs.).

I remain,
Dear Sir Joseph,
Yours truly,
ROBERT THOMSON.

To SIR JOSEPH HOOKER, F.R.S.,
Director, Royal Botanical Gardens,
Kew.

DEAR SIR,—With reference to your letter of 30th December last, addressed to me in Jamaica, and which I only received a few days ago, it having been returned to me here from Jamaica, I beg to submit my further views on bamboo cultivation.

Jamaica has a very striking variety of climates in the lowlands more or less suitable for bamboo growth. This variety of climates has been caused by the improvident destruction of the forest. Bamboo on the drier plains presents a shrivelled and stinted aspect, except when within reach of water, which ensures its wonted luxuriance, it therefore assumes its greatest luxuriance in the most humid districts. Many hundreds of acres of certain districts are densely covered; for instance, a certain part of the parish of St. Thomas is literally covered with it. The plant flowers and yields seed in Jamaica under

very exceptional circumstances, so that seeds are rarely seen. I have never been fortunate enough to see it in flower. It has been widely distributed owing to the readiness with which cuttings grow in most climates. The ripe stems are commonly used to form fences, the post and rails consisting of the stems; the posts, if placed in the ground prior to the rainy season, take root, and unless they are frequently trimmed become irrepressible thickets. Ripe stems of medium size are not uncommonly used by the Negroes as poles on which to support each plant of Yam, which climbs over the pole in their cultivated "provision grounds;" these stems in like manner grow. This will explain the facility with which the plant is propagated—though it is likewise propagable by offsets or rhizomes, I think, however, the stem process of propagation would be in every respect preferable.

With regard to the question as to the period required to produce "crops by planting," I am quite sure that this period could not be diminished by planting offsets from established stools. It should be remembered that by any system of propagation of the bamboo, the first process of rooting is very simple; the result of the first roots is the production of slender, twiggy shoots, but as these latter become matured, the increased vigour of the root action creates stems with proportionately increased strength, and so on step by step until the fully developed stems are producible; the whole length of time, from the time of planting, as I have already mentioned, for the maturation of the crop being at least two years.

An individual stool, if influenced only by the ordinary rainy seasons, I think would not produce more than one crop in a season, but under a system of irrigation I am strongly inclined to believe that two crops would be producible. For the wants of the paper manufacturer it will no doubt be supposed that the available command of bamboo obtainable may be turned to account, instead of having resort to the formation of plantations. I will, however, briefly endeavour to show that a regular plantation possesses immense advantages. The existing bamboo, though only a few miles from shipping ports, is not so conveniently situated as it would be in a special plan-

tation, on which the most advantageous and accessible spots would be set apart and systematically planted in a series of plots, in order to facilitate and economise cutting and carriage. The advantages thus indicated would be considerable, but the great advantage of planting bamboo would be that of having it brought under the influence of irrigation, as it is peculiarly a water-loving plant.

It is well known that general crops of bamboo shoots are only produced after heavy rains, a fall of from 15 to 30 inches; such rains usually occur two or three times a year in Jamaica; the time young shoots take to spring from the ground up to about 25 feet (they are at this height in a fit condition for your requirements) after such rains averages five weeks. Irrigation would produce constant action at the roots, and there can be no doubt that by the process of cutting, which I advocate (*vide* my letter of the 6th Nov.), several crops a year may be secured; indeed, a continuous succession of cropping could be assured by systematic cultivation and irrigation.

To those who have not visited the tropics it is impossible to conceive the extraordinary luxuriance of this gigantic grass. The description you give in your valuable pamphlet is far short of its majestic grandeur.

In laying out a plantation, I think that cuttings should be set about four or five feet apart; thus by planting thickly the intervening surface would be expeditiously occupied by the stools, and this system ensures the benefit of fostering among the plants a reciprocal tendency to shoot upwards.

The cost of planting would be about £2 per acre. After planting, four or five weedings, costing ten shillings, would be given during the two years required to establish the plantation. Subsequently to this cultivation would be absolutely dispensed with, except the application of water and a judicious system of cutting out the stems.

The Government of Jamaica has constructed, at great expense, magnificent irrigation works on the St. Catherine Plain, surrounding Spanish Town, and as very little advantage has been taken of this precious adjunct to tropical agriculture, land is obtainable at a very cheap rate, and it is most conve-

niently situated, as the railway connects it with Kingston, only 15 miles distant.

The irrigation works are constructed to irrigate upwards of 14,000 acres, but only a few hundred acres of cultivation have actually been brought under the influence of this water. Labour would be abundantly obtainable at 1*s.* 6*d.* a day; hundreds of strong Negro labourers would be at command all the year round, and for rough and continuous hard work the Negro is far superior to the coolie, and they prefer any kind of work to sugar estates work.

The Government undertake to supply a quantity of water (as I mentioned in a previous letter to you) equivalent to a rainfall of 60 inches a year for £1 per acre per annum; this is very moderate, as it would certainly double or treble the crops of bamboo annually as compared with the ordinary seasons. The average rainfall of the locality in this irrigation scheme is about 40 inches.

Our bamboo is *Bambasa vulgaris*, but, of course, you are aware that all the varieties are most productive in localities in which moisture is most abundant. This is a most important consideration, in view of the production of bamboo in Jamaica, and one which has, perhaps, not received any attention; the variety of climate as regards moisture is very remarkable. The destruction of the forest in most parts has materially lessened the rainfall; certain districts are too dry for bamboo to exist in, others only afford sufficient moisture to maintain the bamboo in a condition of very partial luxuriance; it therefore follows that districts having a constant precipitation of rain, with a normal average of from 80 to 100 inches a year, are best adapted for this plant. Astonishing crops under irrigation, therefore, would be obtainable at a small cost of production, for it would require little or no cultivation beyond its first establishment.

I agree with you that it would not answer to export the bamboo in any other way than manufactured into paper stock, not only on account of the great difference in the cost of transport, but owing to the deterioration of the article in tran-

sit, when it is sent in a crude state, due to the difficulty in drying the young stems, even after crushing.

I may mention, that before your pamphlet was published I was impressed with the notion that bamboo was destined to become the most valuable of all materials for paper-making, by reason of the quantity of it producible per acre—a quantity of fibre far greater than can be produced from any other plant, a fact to which you have referred. It should be remembered that bamboo grows its whole height in a few months, that the great bulk of it is composed of fibre which is convertible into paper stock, and that it produces its stems so closely, that is to say, each stem about 60 feet high (*Bambasa vulgaris*) occupies about half a square foot. Thus it does not require, as you state at page 8 of your pamphlet, two feet; half a dozen at least grow within two feet. Indeed, I should scarcely like to say what quantity of bamboo may be realised per acre, but it may be safely predicted that it will be so large that it will revolutionise the paper trade.—Remaining yours truly,

ROBERT THOMSON.

11, QUEEN-SQUARE, BLOOMSBURY, LONDON,
22nd February 1878.